Streaming Current Detector
Model SC4200

INSTRUCTION MANUAL

Manual No. : 339-0030-000
Rev. : B
Rev. Date : 03/2022

PRECAUTIONS

For Pumps with PVC & 316SS Liquid Ends
WHEN USED IN SWIMMING POOLS OR SPAS / HOT TUBS (ANSI / NSF 50)

Caution on Chemical Concentration:

There is a potential for elevated chemical concentration during periods of no flow, for example, during backwash in the system. Steps, such as turning the pump off, should be taken during operation or installation to prevent this. Contact your sales representative or distributor about other external control options to help mitigate this risk.

Flow Indicating Device:

To ensure operation of the pump it is recommended that some type of flow indicating device be installed to measure water flow rates and be appropriate for the output of the pump. Contact your distributor or sales representative for further information.

Head Loss / Over Pressure Protection / Back Pressure-Anti-Siphon Valve:

- Milton Roy metering pumps are positive displacement. Head loss is not applicable to the pump.
- To ensure safe operation of the pump, it is recommended that some type of safety / pressure relief valve be installed to protect the piping and other system components from failing due to excessive pressure.
- If you are pumping downhill or into low or no system pressure, a back pressure / anti-siphon device should be installed to prevent over pumping or siphoning. Contact your distributor or sales representative for further information.

Additional Operation and Installation Instructions for 316SS or PVC Liquid Ends:

- Application of this pump to swimming pool / spas only evaluated to NSF / ANSI 50.
- There is a potential for elevated chemical concentration during periods of no flow, for example, during backwash in the system. Steps, such as turning the pump off, should be taken during operation or installation to prevent this. See your sales representative or distributor about other external control options to help mitigate this risk.
- Liquid Compatibility CAUTION: Determine if the materials of construction included in the liquid handling portion of your pump are adequate for the solution (chemical) to be pumped. ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to SDS precautions from your solution supplier. Reference a Milton Roy Material Selection Chart for aid in selecting appropriate material of construction for fluids of your specific metering pump. Contact your sales representative or distributor for further information.

GENERAL PRECAUTIONS FOR ALL PUMPS

The following precautions should be taken when working with metering pumps.
Please read this section carefully prior to installation.

Protective Clothing

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to **Material Safety Data Sheets** for the solution being pumped.

Hearing Protection

It is recommended that hearing protection be used if the pump is in an environment where the time weighted average sound level (TWA) of 85 decibels is exceeded.
(as measured on the A scale slow response).

Electrical Safety

- Remove power and ensure that it remains off while maintaining pump.
- **DO NOT FORGET TO CONNECT THE PUMP TO EARTH.**
- Electric protection of the motor (Thermal protection or by means of fuses) is to correspond to the rated current indicated on the motor data plate.

Liquid Compatibility

Verify if the materials of construction of the wetted components of your pump are recommended for the solution (chemical) to be pumped.

Pumps Water "Primed"

All pumps are tested with water at the factory. If your process solution is not compatible with water, flush the **Pump Head Assembly** with an appropriate solution before introducing the process solution.

Plumbing and Electrical Connections

Always adhere to your local plumbing and electrical codes.

Line Depressurization

To reduce the risk of chemical contact during disassembly or maintenance, the suction and discharge lines should be depressurized before servicing.

Over Pressure Protection

To ensure safe operation of the system, it is recommended that some type of safety / pressure relief valve be installed to protect the piping and other system components from damage due to over-pressure.

Lifting

This manual should be used as a guide only - Follow your company's recommended lifting procedures. It is not intended to replace or take precedence over recommendations, policies and procedures judged as safe due to the local environment than what is contained herein. Use lifting equipment that is rated for the weight of the equipment to be lifted.

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MILTON ROY LIMITED WARRANTY
STREAMING CURRENT DETECTORS

The Milton Roy Company ("Company") warrants that its pumping products will be free from defects in title, and so far as of its own manufacture, will be free from defects in materials and workmanship for a period of thirty six months from shipment by the Company. The Company additionally warrants that all of its other products, including actuators, will be free from defects in title, and so far as of its own manufacture, will be free from defects in materials and workmanship for a period of twelve months from shipment by the Company. The Company will, at its option, repair or replace its products provided the Company's inspection reveals the products to have been defective or nonconforming _within the terms of this warranty. This warranty is expressly conditioned upon the following: (a)proper installation, maintenance, and use under the Company specified service conditions, (b)prompt notice of nonconformance or defect, (c) the. Company's prior written authorization for return, (d)the products being returned to the Company, or at the Company's discretion, to a Factory Authorized Service Centre, all at no cost to the Company. The Company will deliver repaired or replacement products Ex Works its factory or Factory Authorized Service Centre. Products not of the Company's manufacture are warranted only to the extent provided by the original manufacturer. The Company shall not be liable for damage of any kind resulting from erosive, corrosive or other harmful action of any liquids, gases, or any other substance handled by the Company's products.

THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS, OR LIABILITIES, WHETHER EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM THIS CONTRACT, ITS PERFORMANCE, OR IN CONNECTION WITH THE USE OF, OR INABILITY TO USE THE COMPANY'S PRODUCTS.

The liability of the Company in respect of all damages, losses, costs or expenses, whether suffered or incurred by the Purchaser or any third party arising in any manner or incident related to this contract or the performance hereunder, shall be limited in the aggregate to the actual price paid by the Purchaser to the Company.

Revision B **15 March 2022**

SC4200 SPECIFICATIONS

Power Required	115 VAC, 50/60 HZ (standard); 230 VAC, 50 HZ (optional)
Instrument Output	Two 4-20 mA Streaming Current Signals: 1 factory calibrated output; 1 customer calibrated output (max. 500 OHM load each)
Meter Readout	Digital: -100 to+ 100 Streaming Current Units
Operating Modes	CALIBRATION and RUN mode selectable
System Accuracy	± 1 % of full scale
Response Time	Less than 5 seconds
Gain Adjustment	Full range continuous from 1 to 10 on front panel; additional internal gain adjustment
Zero Adjustment	Full range
Signal Filter	Adjustable low pass
Sample Cell	Flow through, external type; Manual Jet Wash connection (standard); Automatic Jet Wash System (optional)
Sample Wetted Parts	PVC, Delrin, PTFE, & Silver
Sample Connections	Barb Type, 1/2" ID tube (standard) Barb Type, 1" ID tube (high flow)
Alarms	High and low adjustable; Relays: SPST, 0.4 amps at 115 VAC
Operating Temperature	32°F to 120°F (0°C to 50°C)
Enclosure	NEMA 4X, 316 Stainless Steel
Weight	24 lbs.

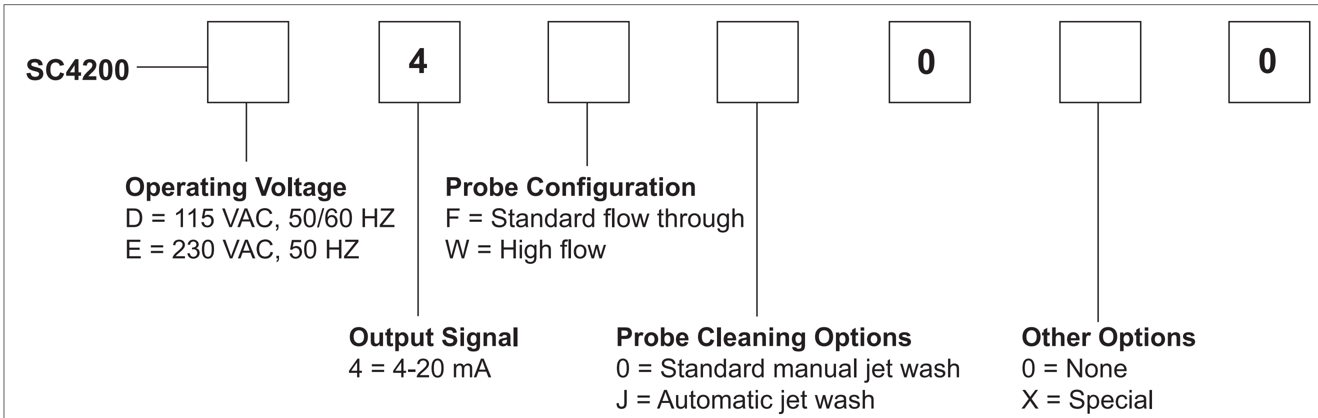

Figure 1. SC4200 Model Code

SECTION 1 - DESCRIPTION

1.1 PRINCIPLE OF OPERATION

The Milton Roy Streaming Current Detector (SCD) is an on-line electrokinetic charge analyzer that offers monitoring, measuring, and/or control functions for the coagulation process. It is the only on-line instrument that directly measures the result of coagulant addition.

The SCD instantaneously measures the electric current generated between two electrodes by charged free counter-ions in a continuous water or wastewater sample. The counter-ions are hydraulically sheared from free colloidal particles present in the water sample which are adsorbed on the walls of the probe cell.

The shearing action is caused by a motor driven plunger reciprocating in the cell bore which hydraulically removes the ions and carries them past the electrodes. The result is an alternating streaming current that is proportional to the charge condition of the water. The charge condition, or net charge density, depends on the excess of positive or negative ions present in the water after coagulation.

The streaming current signal from the probe electrodes is processed by the main electronics board which also receives a timing signal from a slotted disc mounted on the motor shaft. The result is a 4-20 milliamp output and display in streaming current units which is proportional to the charge condition of the sample. This output can then be used to monitor or control the coagulation process. A typical streaming current versus coagulant dose curve is shown in Figure 2.

1.1.1 MILTON ROY SCD MODELS

The Streaming Current Detector is available in three models:

- Model SC2200 Sample Analysis Module-A Remote Sampling Station which provides a 4- 20 milliamp signal proportional to streaming current and is used in conjunction with the RM6200 Remote Monitor Station or RM7200 Remote Controller Station.
- Model SC4200-A monitor station which provides a display in streaming current units between -100 and +100, 4-20 milliamp output, and alarm functions. The SC4200 can be mated with the RC7200 Remote Controller Station to provide a closed loop coagulant control system.
- Model SC5200-A process controller station which provides a display in streaming current units between -100 and +100, 4-20 milliamp output, and an integral PID (Proportional + Integral+ Derivative) controller for complete closed loop coagulant dosing control.

In all three models an Automatic Jet Wash cell cleaning system can be specified to ensure signal reliability in dirty or high solids processes.

1.2 SCD BENEFITS

The SCD allows continuous monitoring of the coagulation process, thereby providing consistent water quality under varying treatment conditions. The SCD can help maintain:

1. Uniform chemical dosing proportional to the suspended solids content of the· water or wastewater.
2. Uniform chemical dosing regardless of fluctuations in suspended solids and/or raw water flow rate.
3. Uniform chemical dosing regardless of variations in the concentrations of the coagulant chemical solution.

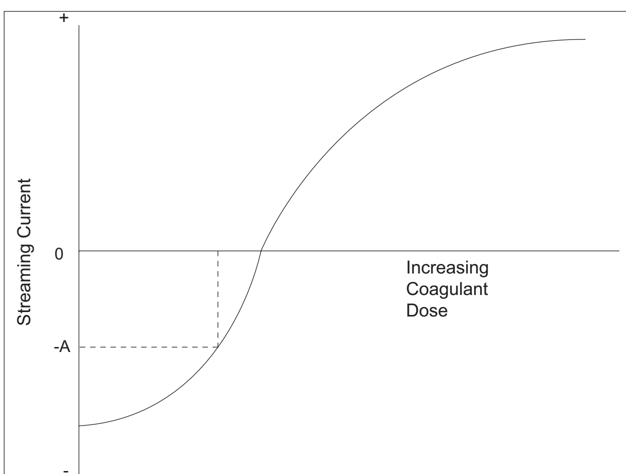

Figure 2.
Typical Streaming Current Vs. Coagulant Dose Curve

1.2.1 Water Treatment Benefits

In water treatment applications, the SCD will maintain a setpoint which has been selected using jar tests or other observations. This setpoint corresponds to the optimum charge condition in the treated water which provides consistent and fully compliant finished water quality. The SCD can provide:

- Reduced coagulant usage for the same treated water quality, resulting in reduced costs.
- Reduced sludge volume due to optimum coagulant dosing.
- Longer filter runs due to reduced sludge formation.
- Automatic operation of the coagulation process, permitting reduced manpower or unmanned operation.
- Minimum aluminum residual as a public health measure.
- Precise and consistent coagulant dosing to remove Giardia cysts.
- Tighter pH control due to optimum coagulant dosing.

1.2.2 Wastewater Treatment Benefits

In wastewater treatment applications, the SCD will monitor and maintain the optimum charge condition in the treated wastewater or sludge as established by suspended solids measurements, cake solids measurements, or other observations. The SCD will allow optimization of the coagulant dosage at all times, thereby providing:

- Lower coagulant chemical costs by maintaining the appropriate dosing as sludge or wastewater conditions change.
- Lower sludge disposal costs by eliminating overdosing and providing the driest possible cake.
- Reduced manual supervision of belt filter press, centrifuge, or dissolved air flotation systems.
- Automatic Control capability of wastewater clarification and sludge dewatering processes.

2.1 PRE-INSTALLATION CHECKLIST

Before installing the SC4200, check the instrument for damage that may have occurred during shipping. Contact Milton Roy if missing parts or if damage is suspected.

The following is included with the SC4200:

- Instruction Manual
- Spanner wrench (for probe removal)
- Potentiometer screwdriver (for main circuit board adjustment}
- 2 spare fuses (1 amp “slo-blo”)
- 1/8” Allen wrench
- 2 barbed tube connectors (3 connectors are included in Auto Jet Wash equipped units)
- 2 hose clamps
- 1/2” NPT ball valve (Not included with Auto Jet Wash units)

2.2 MOUNTING

The SCD should be installed as near to the sampling point as possible (see Section 3, Sample Requirements). The SCD is housed in a NEMA 4X, 316 stainless steel enclosure and can be mounted outdoors provided it has adequate protection from the elements.

Standard industrial practice should be followed to isolate the SCD from spills, rain, snow, and direct sunlight during operation. This prevents damage to the finish and prevents possible overheating in direct sunlight.

⚠ CAUTION **THE SCD MUST BE PROTECTED FROM FREEZING TEMPERATURES (32°F, 0°C) AND TEMPERATURES ABOVE 120°F (40°C).**

The SCD should be mounted vertically on a flat surface with clearances as shown in Figure 3 for standard units or Figure 4 for Auto Jet Wash equipped units. A minimum of 6 inches (15 cm) clearance should be provided on either side of the unit and beneath the probe to facilitate installation and maintenance.

2.3 ELECTRICAL CONNECTIONS

The instrument’s power requirement is coded in the model number as shown in Figure 1.

1. The instrument terminal block connections are accessed by removing the side panel on the unit. Three terminal blocks are available (see Figure 5):
   - Terminal Block 1 (TB1): Instrument Power Connections
   - Terminal Block 2 (TB2): Reserved for Automatic Jet Wash Only
   - Terminal Block 3 (TB3): Signal and Alarm Connections
2. Two openings for 1/2 inch conduit fittings are provided in the bottom of the enclosure. The unsealed opening is for power and alarm cables. The sealed opening is used to route the milliamp signal cable if required. A third opening is also available on non-Automatic Jet Wash units. On Auto Jet Wash units this opening is reserved for the Jet Wash valve Wiring.

IMPORTANT:

Connections must be made through cable connectors that will maintain the integrity of the NEMA 4X box (indoor/outdoor, weather and dust proof), Seal all unused openings with the conduit hole seals provided. All electrical wiring and connections should be made in accordance with local wiring codes.

2.3.1 Instrument Power Connections

IMPORTANT:

A surge suppressor is recommended on the instrument power if line surges are anticipated.

Connect the power leads to the appropriate terminals on terminal block 1 (TB1) as shown in Figure 5, Typical Wiring Connections.

IMPORTANT:

For proper operation, always observe correct polarity on TB 1: Terminal 1-Hl,· Terminal 2-NEUTRAL.

Connect the ground lead to the stud on the bottom of the box using the connector provided.

2.3.2 Instrument Signal Connections

Two 4-20 milliamp output signals are provided on the SC4200 (see Figure 5, Typical Wiring Connections):

1. Streaming Current (SC) Output is available across terminals 8 and 9 of TB3. This signal is the direct 4-20 mA streaming current signal from the main circuit and can be used to monitor or record the streaming current output from the instrument. Gain and zero functions for this output are controlled by the potentiometers on the main circuit board.

IMPORTANT:

If SC output is not utilized, a jumper must be installed across terminals 8 and 9 of TB3.

2. Process output is provided across terminals 5 and 6 of TB3. This output can be adjusted using the front panel GAIN and ZERO controls with the instrument set to RUN mode. In CAL mode, this output is the same as terminals 8 and 9 in (1) above.

The process output and streaming current output signal circuits have a maximum of 500 ohms load resistance. Use a digital multimeter to check the DC circuit load of the controlled device (controller) or recorder.

All output signals should be carried through shielded cable (20 or 22 AWG is recommended) and kept separate from all power leads. Insert the shielded output signal cable through the second opening in the enclosure and not through the same opening as the power leads. Observe correct polarity on all 4-20 mA output signals.

If the SC4200 is being connected to a RM6200 monitor or RC7200 controller, maximum separation should not exceed 3000 feet (1000 meters). Check the circuit load to ensure the 500 OHM load rating has not been exceeded.

2.3.3 Alarm Connections

Two single pole, single throw (SPST) relays are provided to trigger an alarm in the event the SCD reading goes outside a preset high and low limit. One relay contact is reserved for the high limit and one for low. The relays are normally open and rated for .35 amps at 120 VAC.

A typical alarm connection in which the alarm will be activated if the signal falls below the low alarm setting is shown in Figure 5.

Alarm wires should be routed through the power cable entry to minimize interference with the milliamp output signal

2.4 SAMPLE CONNECTIONS

1. Barbed rube connectors are provided for the probe inlet and outlet to connect the sample supply and drain. These connectors are for 1/2 inch [1.25 cm] ID tubing if the unit is equipped with a standard probe or 1 inch [2.5 cm] ID tubing if the unit has a wastewater probe. Flexible polyethylene or PVC tubing is recommended for all sample lines. Use hose clamps to maintain a tight connection.

⚠ CAUTION **HARD PIPING INTO THE PROBE MAKES SERVICING THE INSTRUMENT IMPOSSIBLE AND CAN DAMAGE THE PROBE. NEVER ATTACH METALLIC PIPING DIRECTLY TO THE PROBE.**

2. Inlet and outlet ports are interchangeable. The flexible inlet and outlet lines should be long enough (approximately 12 inches [30 cm]) to allow probe removal.
3. The outlet or drain connection should not exceed 3 feet (1 m) whenever possible to avoid restricting the flow. If a longer drain must be used, the outlet tubing should terminate at an atmospheric pressure drain located below the instrument. Always avoid installing valves or other restrictions in the drain line. The outlet stream entering the drain should be easily visible to operators making their rounds.

4. All probes have a 1/8 inch NPT overflow port located on the back of the probe. This port Should be kept clear at all times. Some leakage out this port during operation is normal. If necessary a drain may be installed from this port but it should be kept as short as possible and always terminate below the probe at an atmospheric pressure drain.

2.5 JET WASH CONNECTIONS

NOTE:
If the instrument is equipped with the Automatic Jet Wash option, refer to Jet Wash instruction manual #339-0034-000 for installation.

A 1/2 inch NPT connection (normally plugged) is provided on the bottom of the probe for use in a manual jet wash. The manual jet wash allows the probe to be flushed with clean water by manually opening and closing a user installed control valve. The following guidelines should be followed when installing and using manual Jet Wash:

1. Mount the manual jet wash valve as close to the bottom of the probe as possible, preferably directly to the bottom of the probe. Always use a plastic valve. The 1/2″ NPT PVC ball valve included with the SCD or a similar valve is recommended. (Refer to Figure 6). Putting the valve directly on the probe minimizes the dead volume under the piston in the cell. Trapped air or solids in this volume can affect the SCD reading.

⚠ CAUTION **NEVER ATTACH A METALLIC VALVE OR PIPING DIRECTLY TO THE PROBE. THIS WILL RESULT IN INACCURATE SCD READINGS.**

2. Use only clean plant water to jet wash the probe. Recommended pressure is 25 to 30 psi. Higher pressures may cause the water to overflow past the plunger stem. Consult Milton Roy for compatibility of other cleaning agents if required.
3. The jet wash can be run for as little as 30 seconds or as long as a few minutes. Recovery time is dependent on how dirty the probe was before jet wash. A clean probe should recover in less than 1 to 2 minutes, and a dirty probe may take longer to return to the SC value it had before jet wash was initiated.

⚠ CAUTION **OPERATION OF THE MANUAL JET WASH DURING INSTRUMENT OPERATION WILL CHANGE THE SCD READING.**

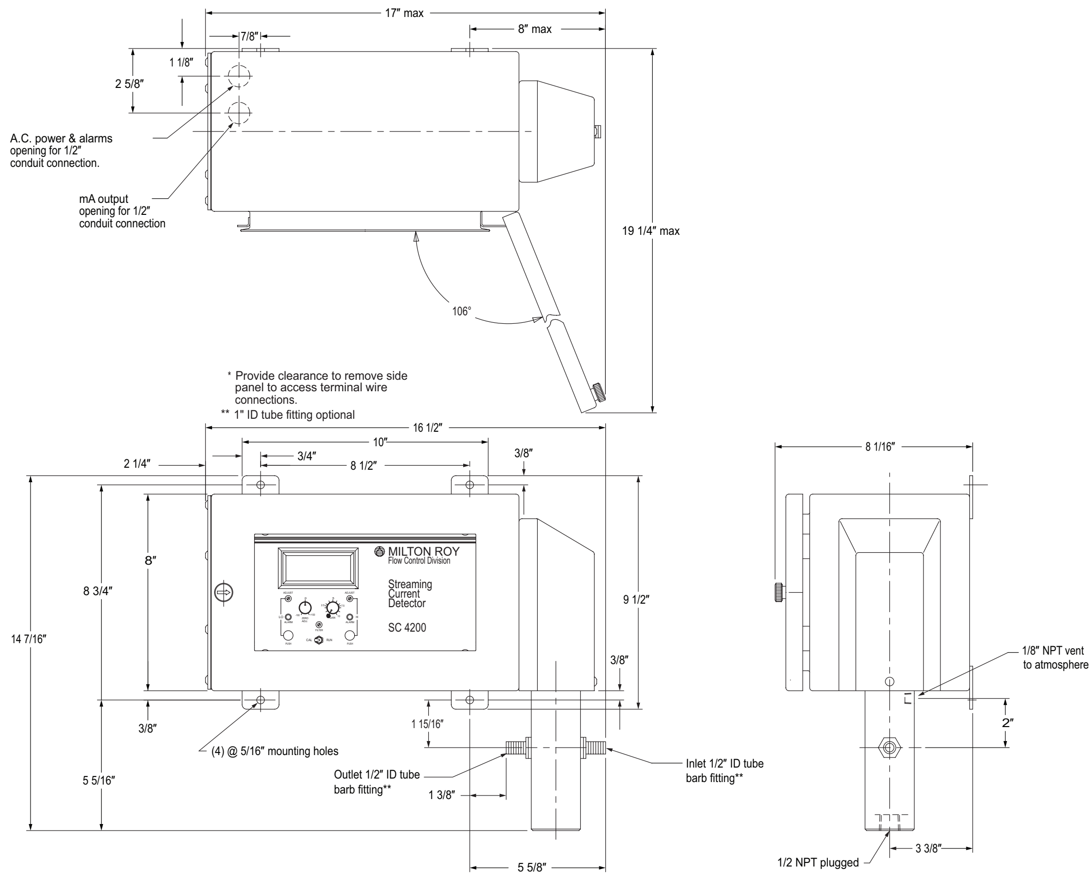

Figure 3. Customer Installation Drawing (C-102-1732-000-C)

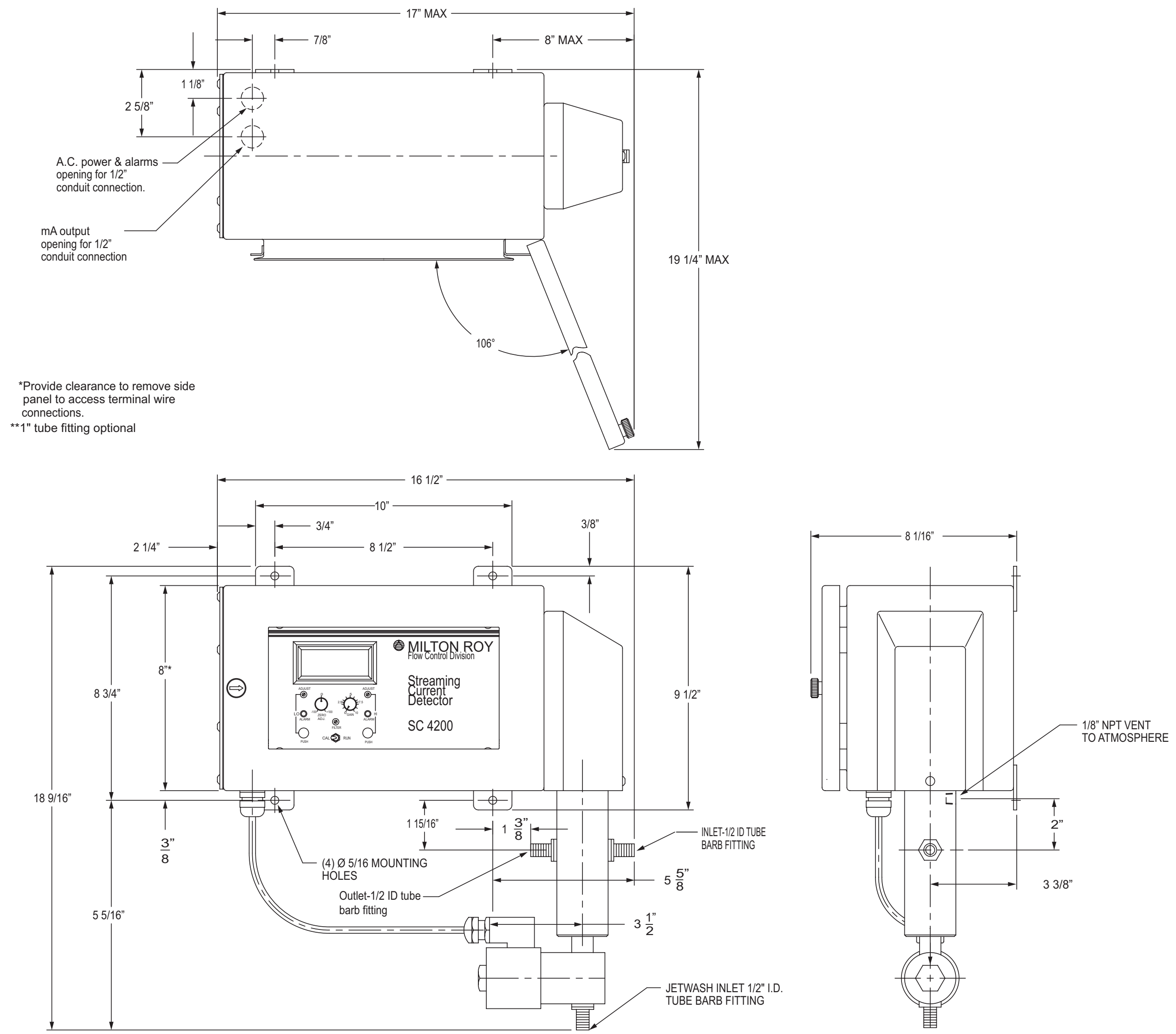

Figure 4. Customer Installation Drawing for Automatic Jet Wash (C-102-1823-000-A).

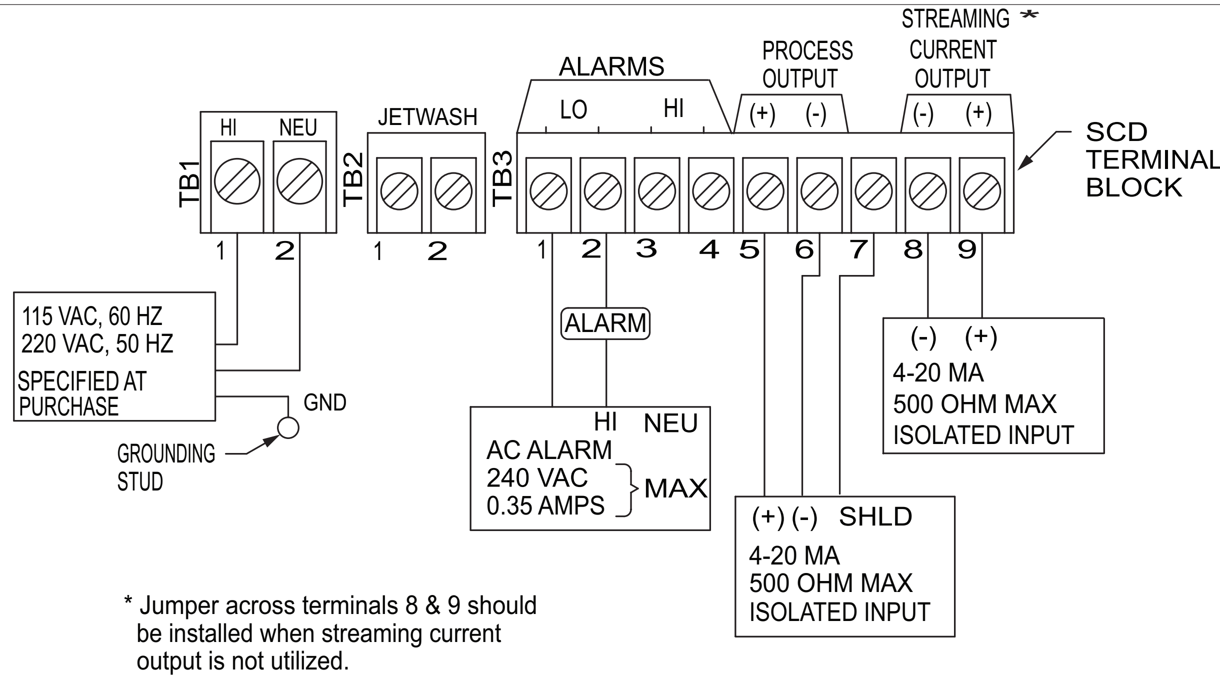

Figure 5. Typical Wiring Connections (C-7 02-7 732-000-C)

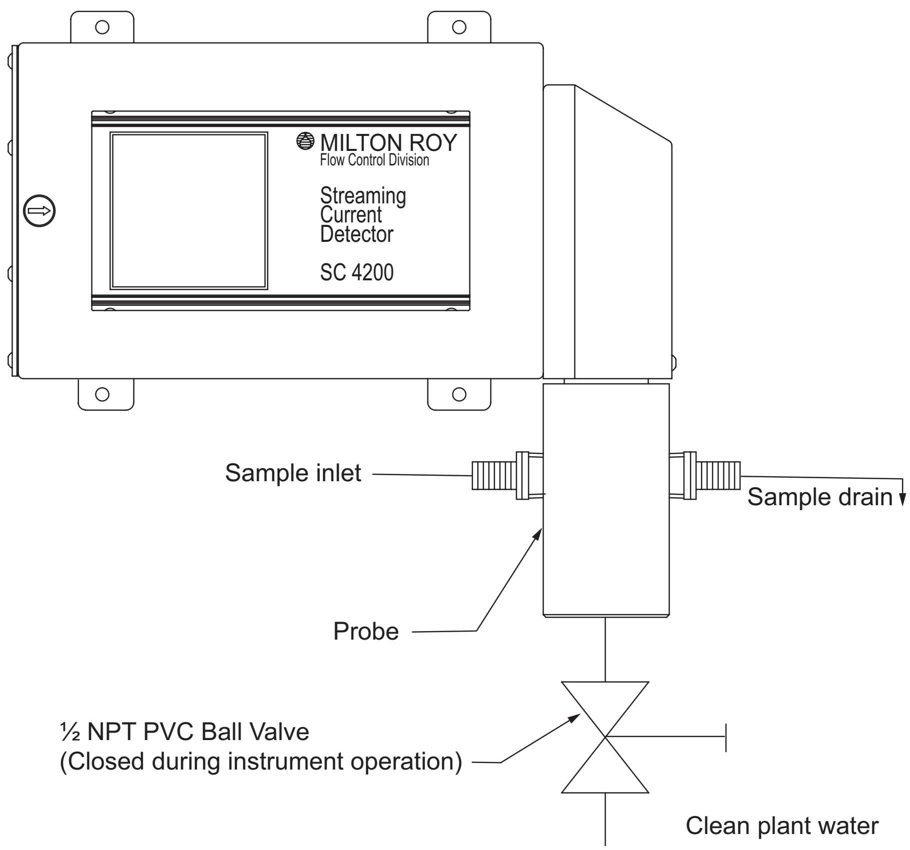

Figure 6. Typical Manual Jet Wash Connection.

3.1 SAMPLE REQUIREMENTS

Reliable and consistent operation of the Streaming Current Detector requires a good quality sample. Obtaining a good sample is probably the single most important operating consideration. The sample to the SCD unit should meet four main requirements:

1. The sample must be representative of the process being monitored or controlled.
2. The sample must be free of foreign matter that can damage the probe or impede sample flow.
3. The sample must be continuous during SCD operation.
4. The sample location must be selected to provide appropriate system delay times.

3.1.1 Representative Sample: Water Treatment

The sample sent to the SCD probe must be representative of the water or influent being treated for the SCD to give accurate readings. The SCD measures the result of coagulant addition, and therefore the sample must be taken after the injection and mixing of the coagulant in the raw water.

Typical sample point in a flash mix system is shown in Figure 7. The sample can be drawn from a number of locations after coagulant addition and mixing:

1. Directly from the flash mix tank using a submersible or other type of sampling pump. If available, a gravity feed from the tank can also be used. Care should be taken to position the sample pump at a point in the tank where good mixing occurs. Some tanks have “dead” spots where little or no coagulant mixing takes place.
2. In the pipeline or weir between the mix tank and flocculators. This location may increase system delay time. Sampling in the flocculator tank normally is not recommended due to long response times and poor sensitivity.

If the process employs a pipeline coagulant injection system, the sample should be taken after the static mixer or mixer section of the piping.

It is essential that the raw water and chemical be well mixed before sampling to obtain a good SCD reading. Follow these guidelines whenever possible:

1. When injecting chemicals into a pipe, use an injection quill or probe to ensure that injection occurs at the center of the pipe. Injecting at the wall of the pipe usually gives poor results.
2. Avoid sampling at the wall of the pipe. Use a probe or quill whenever possible to sample from the center of the pipe.
3. Injection should take place upstream of turbulence causing points such as elbows, pumps, valves, etc. In line static mixers are very effective, even when used in large lines. Injecting into a pipe with laminar flow gives the least mixing effect.

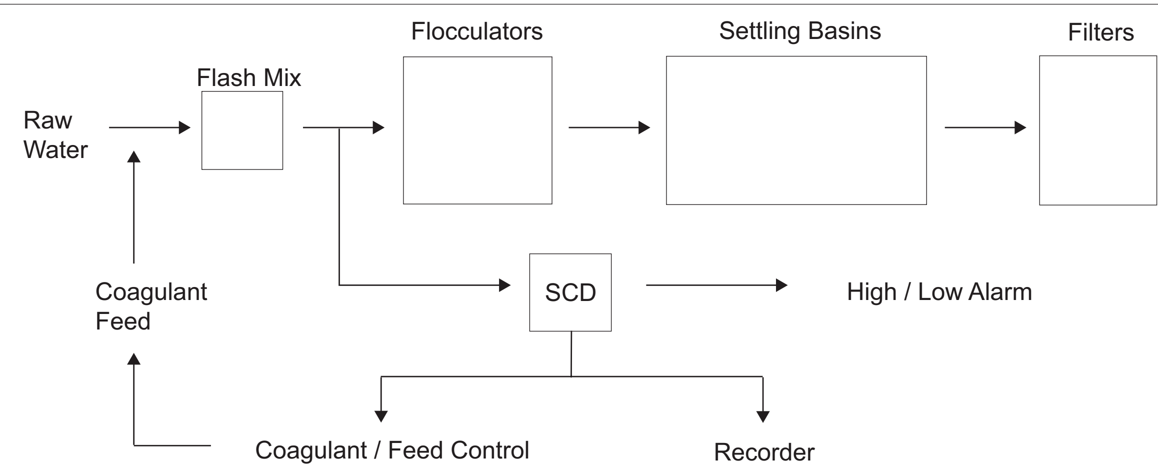

Figure 7. Typical placement of streaming current detector for water treatment.

3.1.2 Representative Sample: Wastewater

In wastewater treatment, the wastewater is sampled after coagulant addition and mixing and before the clarification stage. In dissolved air flotation systems (DAF) this is normally just before the wastewater enters the DAF tank.

In sludge dewatering, the SCD can be applied to belt filter press or centrifuge applications to monitor and control polymer dosing.

For belt filter presses (BFP), the filtrate from the press is sampled at the earliest point possible, normally from the gravity drain section of the press. A tray or collector may have to be fabricated. The sample should be not obtained where filtrate and belt press wash water are mixed.

On centrifuges, the centrate should be sampled wherever the cleanest sample can be obtained. Care should be taken to avoid sampling lumps of sludge that may be present in the centrate, especially during centrifuge startup and shut down.

The Milton Roy factory is available to provide application assistance for the SCD on a variety of wastewater as well as water treatment processes.

3.1.3 Clean Sample

If the water being sampled contains sand, silt, or other particulates or debris, Milton Roy recommends a sample cleaning device be used. Sand and debris will quickly wear the probe sensing area leading to erratic SCD readings and a loss in sensitivity.

Line strainers are normally not recommended because they tend to clog quickly and therefore require frequent maintenance. They also will not filter out sand or silt which are the leading cause of probe wear.

Separators using the hydrocyclone principle will remove sand and debris from the sample without the problems associated with strainers. The :Milton Roy Cyclone Separator (Part #247-0990-000) is effective in removing most fine sand and silt particles from the sample stream.

It may become necessary to establish a regular cleaning schedule to remove particles or coatings that accumulate on the cell. Regular use of the manual Jet Wash or installation of a automatic Jet Wash cell cleaning system will greatly improve signal reliability in dirty samples. Refer to Routine Maintenance for details on probe cleaning.

3.1.4 Continuous Sample

Interruption of sample flow while the instrument is operating will interrupt the instrument signal. This is particularly serious if the SCD is on automatic dosing control through a process controller. Debris blocking the cell flow area can impede or stop sample flow completely, leading to a loss of SCD reading and possible probe damage.

Reliability of the sample flow is therefore very important. The usual recommended flow for the SCD is 2 to 4 liters per minute (.5 to 1 GPM).

Higher flows can be used for more turbid samples to aid in keeping the cell area free of sediment. Sample flow should be kept constant during operation since flow variations may cause SCD signal fluctuations.

A flow alarm should be considered for maximum loop security in an automatic dosing system. Consult Milton Roy for suitable devices.

3.1.5 System Delay Time

The system delay time is the defined as the time between a change in the chemical dosing in the process and actual detection by the SCD.

This time must be sufficiently long to ensure adequate mixing between the chemical and raw water. Typically, the system delay time is a function of two factors:

1. The rate at which the coagulation process takes place.
2. The distance in the process between the chemical dosing point and the SCD sample point.

SECTION 3 - SAMPLE REQUIREMENTS

The coagulation process is, provided good mixing is provided, nearly instantaneous in most processes. The major factor in system delay time is sample point location. Normally a sample point which gives a delay time of approximately 2 minutes gives best results. Sampling at or very close to the chemical injection point will usually provide very short delay times, less than 30 seconds, and is not recommended since it does not guarantee that adequate mixing has occurred.

Long delays times, in excess of 3 minutes, are not recommended for automatic dosing systems. Standard PID process controllers (required for automatic control) are not always able to handle upset conditions when the system delay time exceeds 3 minutes, although results vary from system to system. This constraint is less important if the SCD is being used only for monitoring.

System delay time can be minimized by installing the SCD as close to the sampling point as possible. Pumping the sample to the SCD over long distances will increase the delay time. Whenever possible, The SCD should be mounted close to the sampling point and a monitor used to display and/ or adjust the SCD signal in a remote location. Consult Milton Roy for recommended remote monitors and displays.

3.2 COAGULANT CONSIDERATIONS

The SCD can be used with all common coagulant chemicals applied in water and wastewater treatment. These include:

- Alum (aluminum sulfate)
- Aluminum Chloride
- Ferric Chloride
- Ferric Sulfate
- Polyaluminum Chloride (PAC)
- Cationic Polymers
- Anionic Polymers

Since non-ionic polymers have, by their nature, little or no charge, the SCD will not respond to a system dosing a non-ionic polymer.

Some treatment systems dose a primary coagulant such as alum and a coagulant aid such as a cationic polymer. In these systems the SCD cannot differentiate between the two chemicals and will respond to dosage changes in either or both coagulants. For the SCD to provide effective control in such systems, one chemical dosage should be kept constant (usually the coagulant aid) and the primary coagulant controlled by the SCD.

The addition of lime for pH control before the SCD sampling point may affect the SCD reading.

This occurs for two reasons:

1. The lime itself can act as a mild coagulant, causing the SCD to react to it the same way it might to a weak chemical coagulant.
2. If the lime is not well mixed before the SCD sample is taken, the SCD will react to the free lime particles in the sample. The residual lime may also coat the SCD cell, requiring frequent cleaning.

If possible, always sample after coagulant injection and before the addition of lime. If this is not possible, make sure the lime is very well mixed in the water before the sampling point. This may require moving the sampling point farther down stream from the coagulant and lime injection location.

The same recommendations apply to other pretreatment chemicals including potassium permanganate and powder activated carbon.

The SC4200 Streaming Current Detector features a -100 to +100 streaming current unit display, dual 4-20 milliamp outputs, and high and low alarms. The instrument has two operating modes:

1. CAL Mode: provides the direct streaming current reading from the main board electronics for recording and calibration.
2. RUN Mode: allows zero and gain scaling via the front panel controls to suit process requirements.

The SC4200 is compatible with the Milton Roy Remote Monitor Station RM6200 for remote display applications and the Remote Controller Station RC7200 for remote automatic process control.

4.1 DESCRIPTION OF CONTROLS

The SC4200 has a LCD display which indicates streaming current (SC) units from -100 to +100.

- LOW LIMIT: -100.0 (4 mA process output)
- ZERO: 0.0 (12 mA process output)
- HIGH LIMIT: + 100.0 (20 mA process output) The instrument is operating out of range when the display is greater than + 100.0 or less than -100.0.

The CAL/RUN selector switch on the front panel determines the instruments operating mode.

4.1.1 CAL (Calibration) Mode Operation

With the switch set to CAL, the display and signal output indicate true streaming current at the factory preset scaling. The process signal output at terminals 5 & 6 and direct SC signal output at terminals 8 & 9 are identical and proportional to the display. In this mode the operating zero and gain are adjustable via potentiometers on the main circuit board. See the "Main Circuit Board Adjustments" section for details.

The CAL operating mode allows the user to check the direct SC output to ensure correct operation of the instrument and treatment system. The SC reading in CAL is not affected by gain or zero adjustments made in the RUN mode.

4.1.2 RUN Mode Operation

With the selector switch set to RUN, the front panel ZERO, GAIN, FILTER and ALARM controls are operative. The process output on terminals 5 & 6 will follow the display and can be scaled or zeroed using the controls. In this mode terminals 8 & 9 will still indicate direct streaming current signal from the main circuit board which may or may not be the same as process output. Use of the ZERO and GAIN controls is discussed later.

4.1.3 Alarm Operation

The instrument High and Low alarms can be adjusted to any value within the -100 to +100 operating range. The selection of the alarm value depends on the normal deviation of the SC signal under standard operating conditions. The LO alarm Will activate when the SC value is lower than the preset alarm setting. The HI alarm will activate at SC values above the high alarm setting. When an alarm is activated, the corresponding red LED light illuminates indicating the relay has closed.

4.1.4 Setting Alarm Values

High and low limits are set identically. A potentiometer screwdriver is required.

1. Switch the instrument to RUN mode.

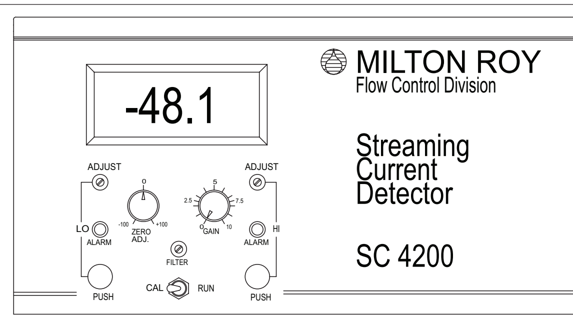

Figure 8. SC4200 Front Panel.

2. Depress and hold the PUSH button under the appropriate alarm, HI or LO The display will show the current alarm value.
3. While holding the PUSH button down, use the potentiometer screwdriver to adjust the potentiometer marked ADJUST until the desired alarm value is obtained.
4. Release the PUSH button. The process value will now be displayed and the alarm is set. You can check the current alarm setting at any time by depressing the PUSH button.

4.1.5 Filter Adjustments

The SC4200 front panel has an adjustable filter to help eliminate the effects of external electrical interference on the SC signal. This filter will also help smooth small fluctuations in output due to process conditions. Additional filtering is also available on the main circuit board.

Increase the filter setting by turning the control clockwise with a potentiometer screwdriver.

4.2 START UP

1. Adjust the sample flow to the instrument to between 2 and 4 liters per minute (0.5 to 1 GPM). The sample should be representative of normal or average chemically treated water (see Section 3, Sample Requirements). Sample flow should be constant during operation to avoid signal upsets.

⚠ CAUTION **DO NOT OPERATE THE INSTRUMENT UNLESS SAMPLE WATER IS FLOWING THROUGH THE PROBE OR THE PROBE IS IMMERSED IN WATER AS IN A JAR TEST. EXTENDED OPERATION WHILE DRY MAY RESULT IN PROBE AND INSTRUMENT DAMAGE.**

2. Turn the instrument on by engaging the power switch on the front panel.
3. Switch to CAL mode and allow the instrument to operate for 30 minutes to stabilize.

4.3 OPERATION

1. With the instrument in CAL mode and sample flow through the cell on, the SCD should give a reading between -100 and +100 SC units. In typical water treatment applications, this reading should be between -20.0 and -50.0 units. Allow the reading to stabilize. This streaming current reading is the process set point for normal chemically treated water as determined by jar tests or other methods in the plant. If the reading fluctuates excessively, check that sample flow is adequate and consistent. Refer to Section 3, Sample Requirements or Section 9, Troubleshooting. Remember that some small fluctuations in the signal may be normal.
2. Disconnect the probe cable at the bottom of the enclosure. The display should read 0.0, ±1.0 unit.
3. Reconnect the probe. The reading should return to the previous process set point. If the instrument reads outside the specified range Or does not return to zero when the probe is unplugged, refer to the Main Circuit Board Adjustments section to adjust internal gain and zero to the specified range.4
4. With the unit operating at process set point (on CAL), switch to RUN mode. The ZERO and GAIN controls on the front panel are now active.

4.3.1 ZERO Adjustment

In RUN mode, the ZERO adjustment allows the user to read deviation from set point instead of direct process value. To adjust the zero, follow these steps:

1. Adjust the ZERO control until the display reads 0.0, ± 0.5 units.

NOTE:
The ZERO and GAIN controls have locking knobs. The locking ring at the base of the knob must be pressed down toward the panel before the knob can be rotated.

2. The process output at terminals 5 & 6 will be 12 mA when the display reads zero. Thereafter the display will indicate deviation from set point. The true process set point can be checked at any time by switching to CAL mode.

⚠ CAUTION **SWITCHING TO CAL MODE CHANGES THE PROCESS OUTPUT AT TERMINALS 5 & 6 TO READ DIRECT SC OUTPUT. IF THE PROCESS SIGNAL IS BEING USED IN A CONTROL LOOP, THE SUDDEN CHANGE IN SIGNAL MAY CAUSE A SIGNIFICANT UPSET IN THE CONTROL LOOP OR PROCESS.**

Example:

The instrument, set on CAL, reads -42.5 SC units. Run mode is selected and the ZERO control is adjusted until the display reads 0.0 units and output at terminals 5 & 6 is 12 mA. As the treatment process changes the SCD reading varies from -10.0 to + 10.0. A reading above the process set point (0.0 units) usually indicates overfeeding of the coagulant and indicates the coagulant feed should be reduced. A reading below 0.0 usually indicates underfeeding and indicates the coagulant feed should be increased. The true SC reading and process set point, -42.5, can be checked at any time by switching to CAL mode.

The ZERO adjustment can also be used to set the SC4200 to read zero at zero streaming current. This is the factory preset position. This corresponds to the approximate zero position on the ZERO adjustment knob.

1. With the instrument in RUN mode, disconnect the probe cable at the connector at the bottom of the enclosure.
2. Allow the unit 1 to 2 minutes to stabilize and then adjust the ZERO until the display reads 0.0, ±0.5 units.
3. Reconnect the cable, The unit is now configured to read process value directly in RUN mode.

4.3.2 GAIN Adjustment

The GAIN controls affects the sensitivity of the instrument to streaming current changes which directly reflect changes in treated water and coagulant addition.

Gain adjustment should be done only after reviewing the following points:

1. A high gain setting may amplify unwanted small deviations in the SC signal. These include electrical noise and small process changes which are unimportant in process control. These small deviations may cause constant fluctuations in the display and control signal.
2. A high gain setting may also cause the instrument to go out of scale in response to moderate SC changes.
3. A low gain setting may cause small but important changes in the treatment process to go undetected.
4. Some recording or control equipment may require a minimum milliamp change before responding. Response must be adequate to go outside the equipment's dead band.

Selection of the correct gain is a function of the treatment process coagulant type, and anticipated system upsets. To determine the gain setting for a particular process, it may be necessary to perform a Process Upset Test.

1. Establish the treatment process set point and zero the instrument following the instructions in the "ZERO Adjustment" section.
2. Adjust the GAIN control to read 1 (fully counterclockwise).
3. Upset the treatment system by changing the chemical dosing rate. This is normally accomplished by adjusting the coagulant feed pump. An alternative upset is to increase or decrease the raw water feed at a fixed coagulant feed rate.
4. Allowing for the system delay time, the time from initiation of the upset to the point the SCD senses the change, note the deviation from set point.
5. If the deviation from set point is too small, increase the GAIN. For example if the upset condition gave a change of -5.0 units and a change of -10.0 units is desired, adjust the GAIN control to approximately 2.
6. If the deviation from set point is too large or the display goes off scale with the GAIN set to "1", the main circuit board gain must be reduced. See the "Main Circuit Board Adjustment" section.

Example:

A treatment process is feeding coagulant at 30 ppm and has a SC process set point of -30.0. The reading is zeroed in RUN mode to reading deviation from zero. An upset is initiated by cutting the coagulant dose to 15 ppm.

After a 2 minute system delay time, the SCD reacts and stabilizes at -5.0 SC units. The operator would like to see a minimum 20.0 SC unit change for a 50% cut in coagulant. The gain is then adjusted to approximately 4 and a display of -20.0. The coagulant dosage is returned to 30 ppm and the test repeated until the required response is obtained.

4.4 MAIN CIRCUIT BOARD ADJUSTMENTS

The SC4200 has GAIN, ZERO, and FILTER adjustments available on the main circuit board which are preset at the factory but are user adjustable. These may have to be adjusted if the instrument reading, when set on CAL, goes out of scale (main board gain preset too high) or the instrument exhibits very low or no response to a change in chemical dose (preset gain too low). Once these are set, all future gain and zero adjustments can be made with the front panel controls.

The adjustments are made using three potentiometers on the main circuit board. On some units these potentiometers can be accessed through holes in the front panel using a potentiometer screwdriver. On other versions of the SC4200, the front panel must be removed to access these adjustments. If required, remove the front panel and allow it to hang freely from the ribbon cable.

⚠ WARNING HIGH VOLTAGES ARE PRESENT ON THE FRONT PANEL CIRCUIT BOARD DURING THIS PROCEDURE. BE CAREFUL NOT TO TOUCH THE CIRCUIT BOARD OR ALLOW IT TO COME IN CONTACT WITH THE ENCLOSURE WHEN POWER IS ON.

Locate the three potentiometers at the front of the main circuit board in the main enclosure or through the holes in the front panel. The for left potentiometer is for ZERO, center is for GAIN, and right is for FILTER. These are 15 turn potentiometers. Use the potentiometer screwdriver included with the SCD to make adjustments.

All gain and zero adjustments to the main board should be made with the mode switch set to CAL and the unit operating.

4.4.1 Main Board Zero Adjustment

The instrument is configured at the factory to read 000.0, ±0.5 units at a streaming current of zero (12 mA output at terminals 8 and 9).

This can be checked and adjusted as follows:

1. With the instrument operating and warm, disconnect the probe cable at the connector located at the bottom of the enclosure. The display should read 000.0, ±0.5 units.
2. If the reading is incorrect, adjust the ZERO potentiometer until the display reads 000.0, ±0.5 units.
3. Reconnect the cable. The unit is now configured to read zero at zero streaming current input and to output 12 mA when SC is zero.

4.4.2 Main Board GAIN Adjustment

Review “GAIN Adjustment” for the front panel prior to making any adjustment to the main board.

With the instrument set on CAL, operate the SC4200 under normal treatment conditions to establish a process set point. If the instrument shows little or no response or reads below -10.0 units, gain must be increased. If the instrument operates out of scale or very close to the scale limits (-100 or+ 100), the gain must be decreased.

To increase gain, use the following procedure:

1. With the unit operating at process set point, record the displayed value. Rotate the GAIN potentiometer clockwise 1 to 2 turns. Allow this reading to stabilize, usually 1 to 2 minutes.
2. Disconnect the probe and adjust the ZERO (if necessary) until the display reads 000.0, ±0.5 units.
3. Reconnect the probe and allow the reading to stabilize. The new output should now be more negative for a negative SC reading and more positive for a positive SC reading.
4. If the required sensitivity is observed, normally between -20 and -70 for water treatment applications, the procedure is complete. If the gain setting is still not adequate then repeat steps 1, 2, and 3 until better sensitivity is observed.
5. The maximum gain on the main board is obtained with the GAIN potentiometer fully clockwise. The potentiometer does not have a hard stop. If required, maximum gain can be achieved by rotating the potentiometer 15 turns clockwise.

To decrease gain, follow the above procedure but rotate the GAIN potentiometer counter-clockwise. Adjust the gain until the instrument operates within the -100 to+ 100 scale at setpoint and during an upset condition.

4.4.3 Main Board FILTER Adjustment

The main board filter adjustment supplements the front panel FILTER adjustment where increased filtering of external interference and signal fluctuations is required. To increase the filter setting, rotate the FILTER potentiometer clockwise.

SECTION 5 - PROCESS SET POINT SELECTION

5.1 INTRODUCTION

The Streaming Current Detector provides a process value which corresponds to the net charge density of the treated water or wastewater. This measurement can then be related directly to the amount of chemical dosing required to maintain proper coagulation and/ or flocculation. The SCD cannot directly determine the correct coagulant dose for a given raw water influent. This is a function of the treatment process, raw water conditions, chemical used, chemical injection point, and many other factors, The optimum coagulant dosage for a particular system should be established by other traditional methods and then the SCD used as a tool to maintain that condition under varying treatment conditions.

5.2 PROCESS SET POINT: WATER TREATMENT

Optimum process set point is the SCD process value that produces a treated water that, after filtration, yields a finished water quality that meets turbidity and color standards. The process set point is maintained by appropriate increases and decreases in the chemical dosing range either manually or automatically (see Section 6). In manual operation the pump dosage is adjusted by the operator to maintain set point. In automatic operation, a programmable controller maintains the established set point.

Several methods can be used to establish the initial process set point.

5.2.1 Observation

Observation of the SCD reading over a period of plant operation is probably the most common method of set point selection. By observing the SCD process value and studying plant operating data, an initial set point can be selected that will ensure adequate chemical dosing for satisfactory finished water quality. During this period, plant operating conditions are optimized using typical off line methods such as jar tests. The established set point can be checked periodically using jar tests to ensure optimum dosing once the SCD is put on line.

5.2.2 Jar Tests

A normal jar test sample tested in the SCD will not yield the correct SCD process set point value. This is because the SCD is designed to provide a reading 2 to 3 minutes after chemical injection, whereas a typical jar test is read after 15 minutes of reaction time. A jar test can be used to establish a rough process set point if the following procedure is used.

1. Prepare the SCD unit for a jar test by disconnecting all fittings from the SCD probe. Locate a beaker large enough so that the probe can be totally immersed in it (typically 1 liter or larger).
2. Conduct a normal series of jar tests to establish optimum coagulant dosing.
3. Repeat the jar test for the optimum dose, but stopping at the time equal to the SCD system delay time. (See Section 3, Sample Requirements for· an explanation of delay time). Immediately immerse the probe in the jar test sample. Use the process value obtained after 2 minutes as the initial process set point.
4. Put the SCD on line and fine tune the initial set point to plant conditions. Note that samples measured by immersing the probe and by flowing through the probe will yield different process values. The jar test method provides a starting point reading which must be refined by on line operation.

5.2.3 Zeta Potential

The SCD process value is directly related to zeta potential and therefore a zeta reading can e used to set SCD process set point. A zeta meter is used initially to establish optimum coagulant dosage and the corresponding SCD reading at this coagulant dose is then used as set point.

Optimum process set point may change seasonally, or in some cases even monthly, in some water treatment plants as the character of the suspended solids and / or color level in the raw water changes. Temperature of the raw water will affect the chemical reaction rate and therefore the SCD process value. Cold water may be more difficult to coagulate than warm water, leading to decreased SCD sensitivity and response.

5.3 PROCESS SET POINT:

WASTEWATER TREATMENT

In wastewater treatment, the optimum set point is that which provides the lowest coagulant dosage while yielding driest acceptable cake or lowest suspended solids in the effluent. In dewatering processes such as filter presses or centrifuges, the following criteria are often used to establish SCD set point.

1. The percent solids in the dewatered sludge cake is optimized by adjusting the coagulant dose. The SCD process value at this condition is then used as set point.
2. Total suspended solids in the centrate or filtrate are monitored and the SCD set point selected accordingly.
3. Centrate or filtrate clarity is monitored by direct observation. A dark effluent usually indicates underfeeding and a milky white effluent overfeeding of coagulant. This is a very subjective measure which requires experienced operators to interpret
4. In belt presses, visual observation of the feed sludge can be used to establish SCD set point. To the trained operator, incorrect coagulant dose is evident in the sludge consistency and color.

SECTION 6 - OPERATING MODES

The SC4200 can be used to monitor the coagulation process or provide a means of direct on-line control of coagulant dosing. Control schemes can be either manual or automatic.

6.1 MANUAL DOSING CONTROL

In manual dosing control, the SCD process value is observed and the coagulant dosage is adjusted by the operator. Typically the process set point is established (see Section 5) and the instrument is zeroed at that condition. Variations of the SCD value from zero indicate the need to adjust the coagulant pump to return the SCD value to zero. A reading greater than zero (the process set point) usually indicates overfeeding and the dosage should be reduced. A reading below zero indicates underfeeding and a increase in coagulant is required.

The operator will usually work within a established dead band around the set point, +5.0 to -5.0 streaming current units for example. Adjustments will only be made if the SCD value moves outside this range. This system can be improved by using the high and low SCD alarms to activate visible or audible alarms at the dead band limits to alert operators.

This type of control is often referred to as manual dead band operation. It gives fair dosing results and good system security provided raw water conditions are stable.

6.2 AUTOMATIC DOSING CONTROL

The full advantages of the SCD are obtained when it is used in a automatic dosing control system. Even raw water that appears uniform has micro- variations over time that can be detected by the SCD and to which the automatic control system responds immediately and accurately. During raw water upsets such as storms, when turbidity increases rapidly, the SCD control system responds with an immediate increase in chemical dosing to maintain the process set point. Operator input is reduced or eliminated in many cases.

A typical automatic coagulant control system usually consists of the SCD, a process controller with PID (Proportional + Integral + Derivative) functions, and a coagulant dosing pump with electronic capacity control capable of accepting a 4-20 milliamp signal.

NOTE:

The SC4200 cannot be used to directly control the dosing device. A PID process controller must be used for correct automatic operation. The Milton Roy RC7200 Remote Controller Station or other compatible process controllers are recommended. Consult Milton Roy for details.

In basic automatic mode, the SCD milliamp output signal is input into the process controller The operator has programmed the controller with the SCD process set point. The process controller compares the SCD process value and set point and sends a modulated milliamp signal to the dosing pump electronic capacity control. The pump responds by increasing or decreasing chemical flow, thus maintaining the treated water at the SCD set point. The output from the controller is a function of the difference between the set point and process value and the controller Proportional, Integral, and Derivative (PID) settings. The PID settings establish the controller response to the magnitude of a SCD signal change versus set point, the response time, and the rate of response.

A recorder can be added to the system to log SCD process value and pump setting. A output limit function in the controller prevents the pump from dosing below a preset minimum value.

6.3 AUTOMATIC CONTROL CONFIGURATIONS

Several automatic control system schemes are available to match the specific requirements of the particular application. There are three basic control plans.

6.3.1 Plan I. Simple Feedback System

Figure 9 shows a simple feedback control system utilizing the SCD to control the dosing pump. The SCD process signal is sent to the process controller where it is compared to the set point. The controller then continuously out puts a 4-20 mA control signal to the dosing pump in response to SCD signal changes. The SC4200 is wired as shown in Figure 10. The recorder is optional but recommended to chart trends in system operation.

6.3.2 Plan II. Feed Forward & Feedback Control System

Figure 11 shows a more advanced control scheme which employs the SCD for feedback control and raw water flow rate for feed forward control. This type of system allows rapid adjustments in chemical dosing based on plant flow while fine tuning the dose with the SCD input. In this case a dosing pump with variable stroke and variable speed control is utilized. The flow signal makes step changes in pump speed to respond to gross flow changes while the SCD feedback from the controller adjusts pump stroke to optimize coagulant dose to streaming current. Typical wiring connections are shown in Figure 12.

6.3.3 Plan III. Modified Feed Forward & Feedback Control System

This plan (Figure 13) is similar to plan II but it simplifies the control scheme by using a dual input controller and eliminates one control input to the pump. The process controller accepts input from the flow meter and SCD, weighs and adds the two signals according to preprogrammed parameters and outputs a control signal to the pump. Such a system is wired as shown in Figure 14.

6.3.4 Automatic Control Plan Selection

The selection of an automatic control plan depends on the individual plant conditions. Plan I is adequate where flow changes are slight. Plans II and III should be considered where flow change greater than 10% are frequent.

Consult Milton Roy for information on chemical dosing pumps for all plans and for additional information.

6.3.5 Automatic Control Operating Considerations

To ensure successful automatic operation, follow the guidelines on sampling given in Section 3, Sample Requirements. The system delay time should be as close to 2 minutes as possible. System delay times above 3 minutes make automatic control difficult to maintain.

To operate correctly on automatic dosing control, the hydraulics of the plant dosing and sampling systems occasionally need improvement. The SCD signal may tend to wander or become erratic even antler perceived stable flow and chemical dosing. The same instabilities that affect the SCD reading usually adversely affect coagulation as well. They may indicate poor coagulant mixing or a poor injection point. These instabilities need to be eliminated or minimized before automatic control can be implemented.

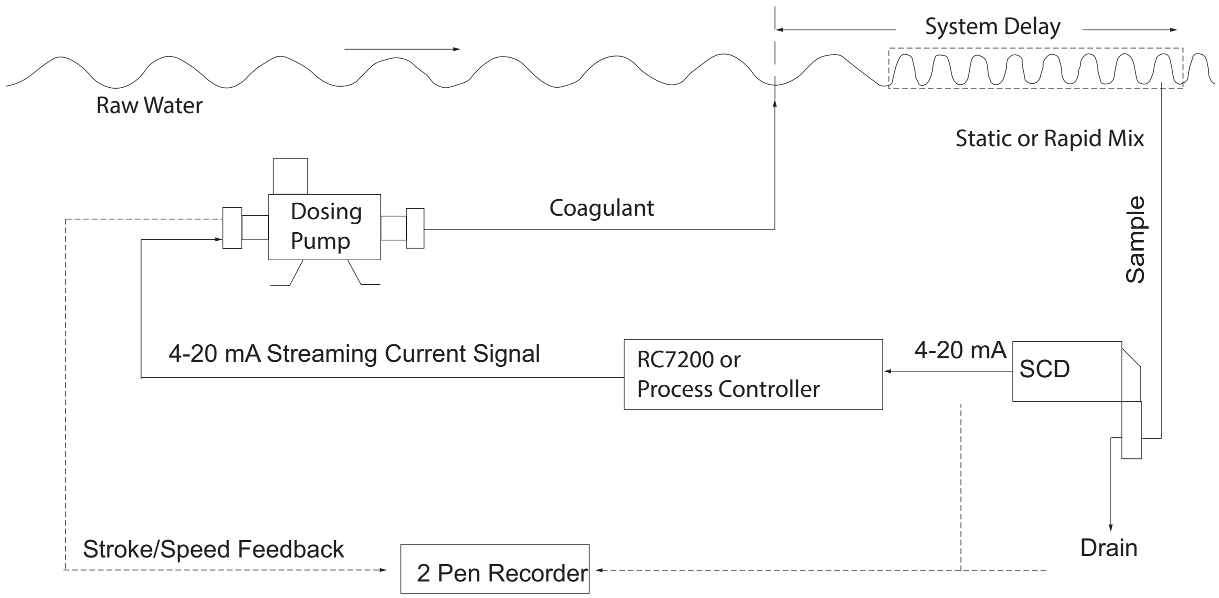

Figure 9. Plan I - Feedback System with SCD Control Only

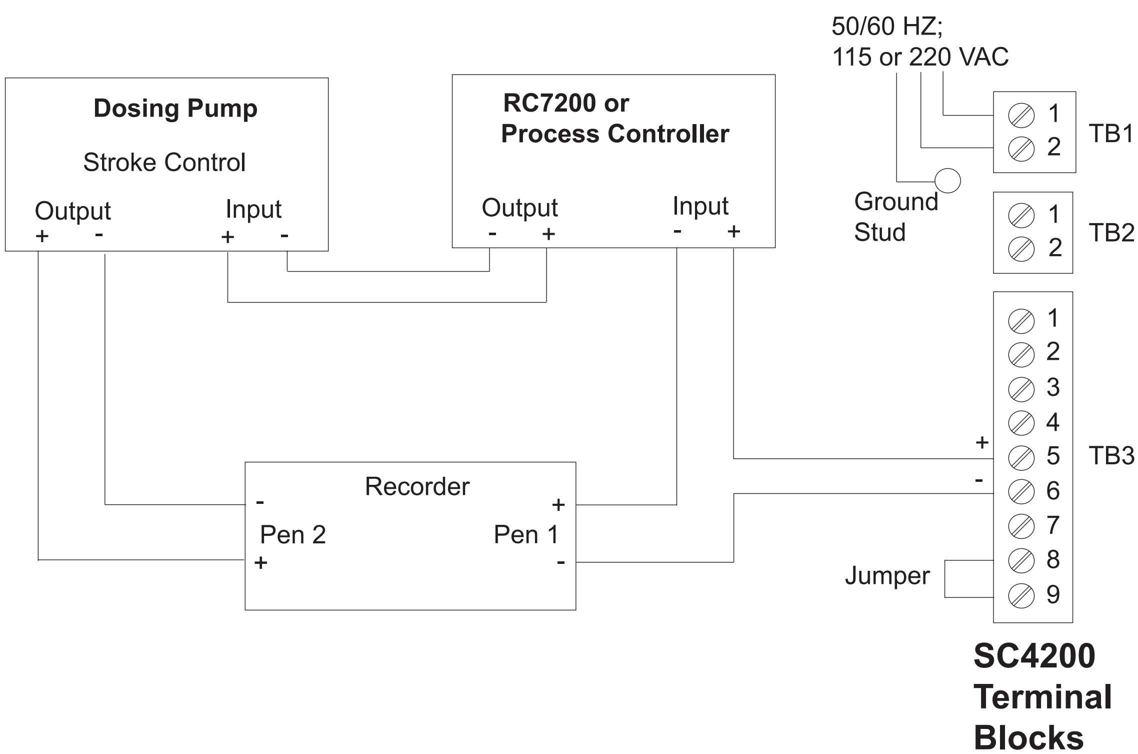

Figure 10. Plan I- Control Loop Interconnections

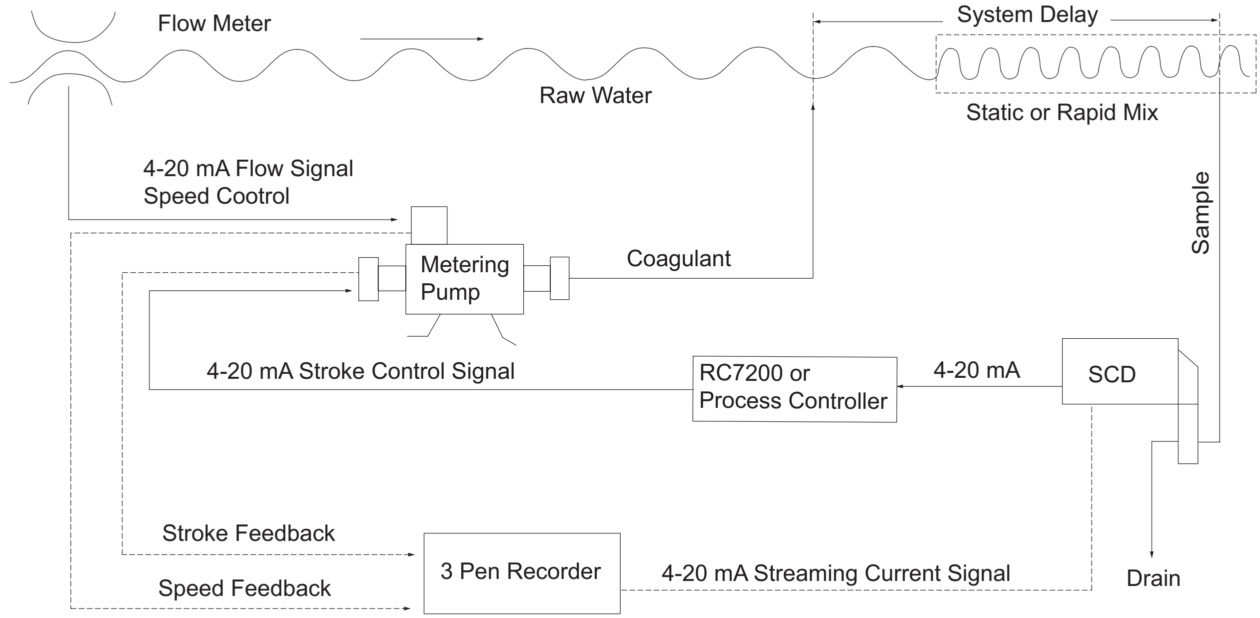

Figure 11. Plan II- Feedback System with SCD Control and Feed Forward Flow Proportioning Control

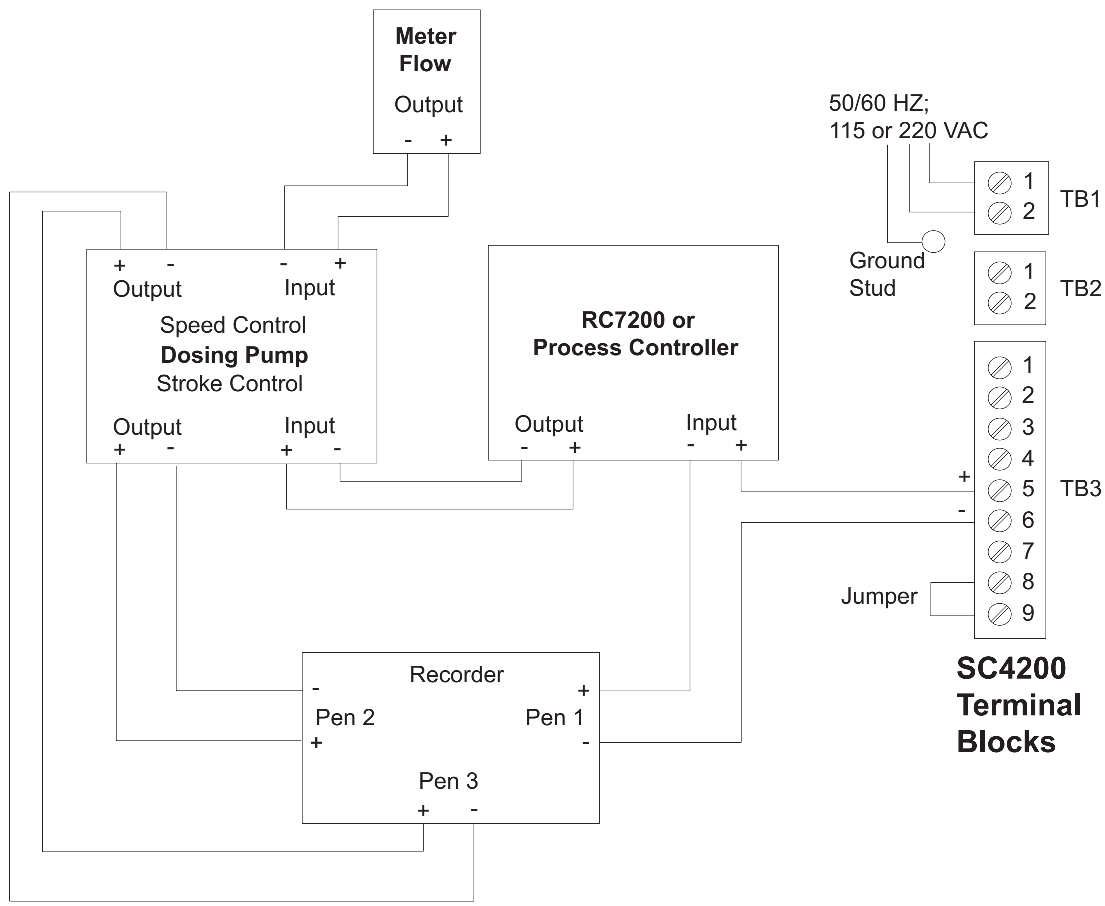

Figure 12. Plan II - Control Loop Interconnections

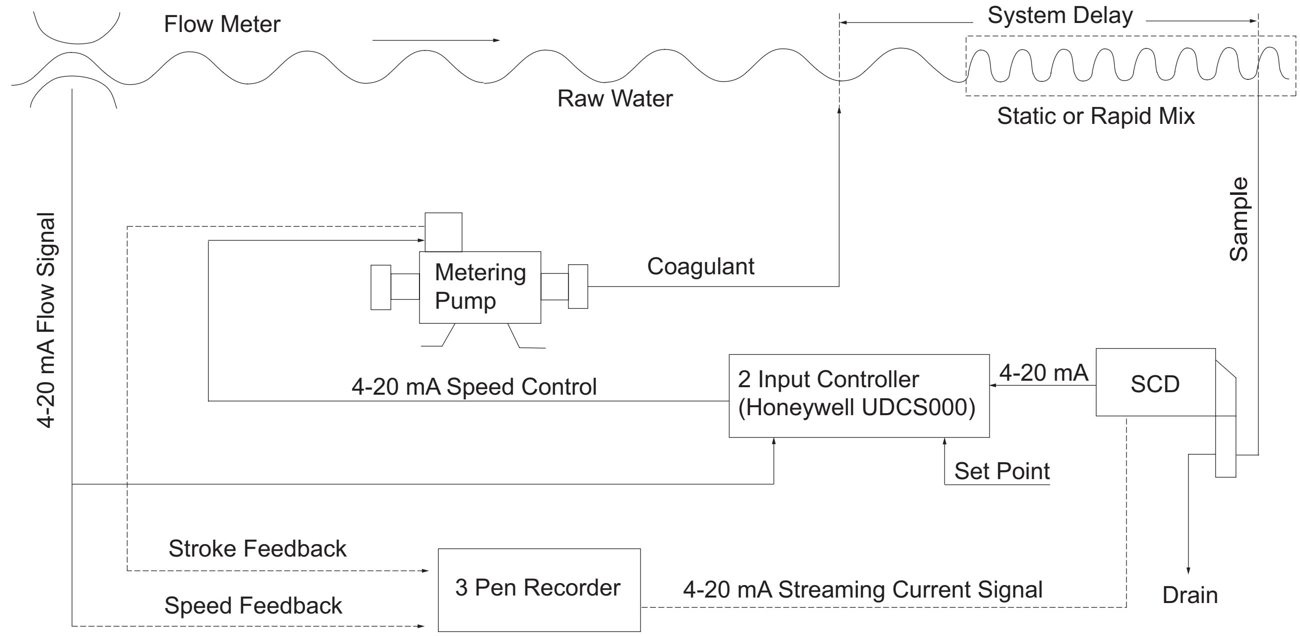

Figure 13. Plan III Feedback System with SCD Control and Feed Forward Flow Proportioning Control.

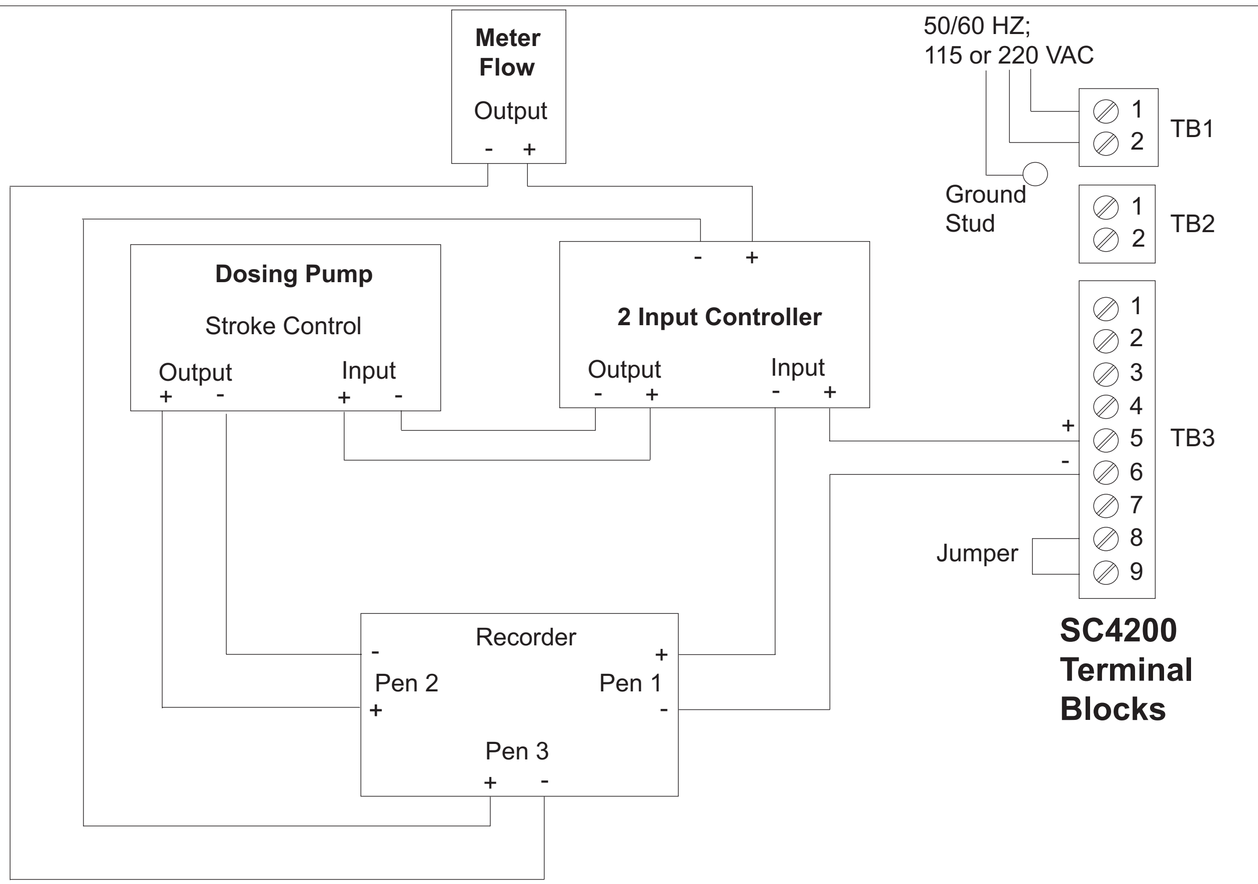

Figure 14. Plan III - Control Loop Interconnections

SECTION 7 - ROUTINE MAINTENANCE

7.1 GENERAL MAINTENANCE

The SC4200 is housed in a Nema 4X, 316 stainless steel enclosure that does not require painting. Regular washdown or cleaning of the enclosure with a mild detergent and water will help preserve the exterior finish and appearance of the unit. Always make sure the enclosure door and side panel are secure before washing down the SCD.

7.2 TIMING SENSOR MAINTENANCE

The SCD timing sensor is located under the probe side cover. Its purpose is to pick up a timing signal from the timing disk located on the bearing assembly.

The timing sensor and disk should be inspected at regular intervals for dirt or debris that may have accumulated on the disk surface or in the sensor slot. The sensor may be fouled as a result of sample fluid leaking past the plunger and spraying on the sensor surfaces. Also, grease from the bearing assembly may work its way into the slot.

To clean the sensor assembly, carefully wipe any contaminants from the sensor disk and around the sensor slot. Ensure that the slot in the disk is clear. Do not use alcohol, thinner, benzene, or other such solvents that can damage the plastic surface of the sensor. Use only commercial electrical contact cleaner to clean the interior of the sensor slot.

7.3 PROBE MAINTENANCE AND CLEANING

The SCD sampling cell consists of a close end bore with two silver electrodes. A close fitting plunger reciprocates in the bore during operation (see Figure 15). The cell surfaces must be kept clean to prevent measurement error.

Under normal operation, the probe is designed to be self cleaning. The reciprocating action of the plunger constantly purges the cell of the sample water and forces out most contaminants that may affect SCD operation, replacing them with fresh samples. The standard manual Jet Wash or optional automatic Jet Wash also help retard the buildup of material on the cell walls.

In many cases contaminants will build up on the cell surfaces over time, Minerals and chemical additives in the water will eventually form deposits on the cell walls. These include coagulants such as ferric and alum, lime, hard water deposits, and potassium permanganate. Sand and other particulate matter can also build up in the cell and cause damage to the cell and plunger.

Signal drift or erratic signals usually indicate the need for cell cleaning. Visual inspection is not always sufficient for determining cell cleanliness, particularly when alum and / or polymer are being dosed. The frequency of cleaning should be enough to prevent drift in the SCD reading. After cleaning, the instrument reading on the same water sample should stabilize very close to the reading obtained before cleaning. If the post-cleaning reading differs, then cleaning should be performed more often. The object is to clean before noticeable signal drift or erratic behaviour occurs.

A regular interval should be established to clean the probe. The frequency of cleaning depends on plant conditions, chemicals dosed and raw water conditions. This can vary from every week to twice a year. Milton Roy recommends monthly inspection and cleaning of the probe to ensure reliable operation. This interval can be extended with the use of the manual or automatic Jet Wash.

7.4 SCD CELL CLEANING PROCEDURES

There are three basic cleaning procedures:

1. Standard Procedure: for simple particulate matter.
2. Special Procedure I: for chemical deposits and coatings.
3. Special Procedure II: for iron or permanganate deposits and stains.

These procedures cover the range of contaminants that are likely to be encountered in water and wastewater. Before cleaning, remove and disassemble the probe as outlined in Section 9.

NOTE:

Sand or other abrasive materials will cause premature wear of the plunger and cell bore, requiring replacement. Abrasive materials must be separated from the sample before it reaches the cell. Refer to Section 3, Sample Requirements.

7.4.1 Standard Procedure

This procedure is appropriate where the surfaces are not heavily stained or discolored and debris trapped in the cell need to be removed.

1. Using a clean test tube or bottle brush, vigorously scrub the plunger surface and cell bore while flushing with clean water. Continue brushing as required to remove any contaminants on the cell surfaces.
2. Flush thoroughly with clean water before reassembling.
3. Operate the SCD on-line for 10 to 15 minutes until it returns to near the original value.

⚠ CAUTION NEVER USE DETERGENT OR OTHER SURFACE ACTIVE CHEMICAL TO CLEAN THE PROBE. DETERGENTS LEAVE A RESIDUAL SURFACE CHARGE ON THE PROBE SURFACES, WHICH IS DIFFICULT TO REMOVE. USE DETERGENTS ONLY AS A LAST RESORT TO REMOVE OIL OR GREASE IN THE CELL.

7.4.2 Special Procedure I

If the SCD signal does not return to its previous value or remains erratic after cleaning using the Standard Procedure, then chemical cleaning is required. This will remove organic and chemical coatings, many times not noticeable by eye, which affect SCD operation.

1. Clean the probe as outlined under Standard Procedure.
2. Prepare a bleach solution of approximately 10 ml household bleach (5.25% Sodium Hypochlorite, NaClO) to 100 ml of water (10:1). This dilute bleach solution oxidizes polymer or other foreign material. It is also very effective in removing organic solids or biological growth in the cell.
3. Using the solution, thoroughly scrub the cell and plunger surfaces.
4. Rinse thoroughly with dean water and reassemble.
5. Operate the SCD on-line for 10 to 15 minutes until it returns to near the original value.
6. If the SCD reading does not return to within 2 SC units of the original reading, repeat the cleaning procedure until satisfactory operation is obtained. Always flush the probe thoroughly with clean water before operating.

⚠ CAUTION NEVER USE DETERGENT OR OTHER SURFACE ACTIVE CHEMICALS TO CLEAN THE PROBE. DO NOT USE BLEACH THAT CONTAINS SURFACE ACTIVE CHEMICALS.

The cell may also be cleaned by running the SCD in the bleach solution in a jar test for a period of time. To do this, first remove all tubing and fittings from the probe. Immerse the probe in the bleach solution and allow to operate for several minutes. The cell should be drained and the probe thoroughly flushed with water before resuming operation.

7.4.3 Special Procedure II

When ferric salts (ferric chloride or ferric sulfate) and / or potassium permanganate ($KMnO_4$) are dosed, the SCD cell can become coated with deposits of iron (reddish to light brown) and manganese (dark brown to black). These stains are not easily removed by scrubbing or bleach and require the use of a stain or rust removal chemical. Milton Roy recommends RoVer™ Rust Remover, available through HACH Company, PO Box 389, Loveland, CO 80539, USA (800) 827-4224.

RoVer™ is a non-detergent based, laboratory chemical stain remover available in 1 pound (454 gm) containers.

Cleaning procedure is as follows:

1. Make a solution of 30 grams RoVer™ to 1 liter of water (approximately 1 tablespoon to a quart of water) and mix well.
2. Disassemble the probe and, using a clean brush, thoroughly scrub the cell bore and plunger with the solution, removing all discoloration on the cell surfaces.

3. Flush the probe cell and plunger thoroughly with water and reassemble.
4. Operate the SCD on-line for 10 to 15 minutes until it returns to near the original value.

As in Special Procedure I, the cell may also be cleaned by running the SCD in the RoVer™ solution in a jar test for a period of time. To do this, first remove all tubing and fittings from the probe. Immerse the probe in the solution and allow to operate for several minutes. The cell should be drained and the probe thoroughly flushed with water before resuming operation.

Figure 16 summarizes the chemical operations for Special Procedures I and II.

7.5 PROBE CLEANING: SPECIAL CONSIDERATIONS

The best cleaning tool for the probe is a stiff bristle test tube or bottle brush which is used exclusively for the SCD to avoid contamination.

Minor scratches on the plunger surface and cell bore are acceptable and will not have a major impact on instrument operation. Replace the plunger if the tip is wearing unevenly and is no longer round as viewed from the end of the plunger. Similarly, if the cell bore exhibits uneven wear and becomes oblong, the probe body should be replaced. As the plunger and cell bore wear, the instrument may lose sensitivity and become erratic.

Under normal operating conditions, it may be necessary to replace the probe assembly at approximately 1 year intervals. Abrasive sample conditions may require more frequent replacement. Very thorough flushing of the probe with clean water is very important after any chemical cleaning operation. Residual cleaning chemicals left on the probe surface will affect instrument operation and may take long periods to wash away in operation.

Remember that the SCD signal is both a function of the condition of the probe and the quality of the sample. If cleaning does not improve an erratic signal or signal drift, always double check that sample requirements have been met (Section 3) before consulting the factory.

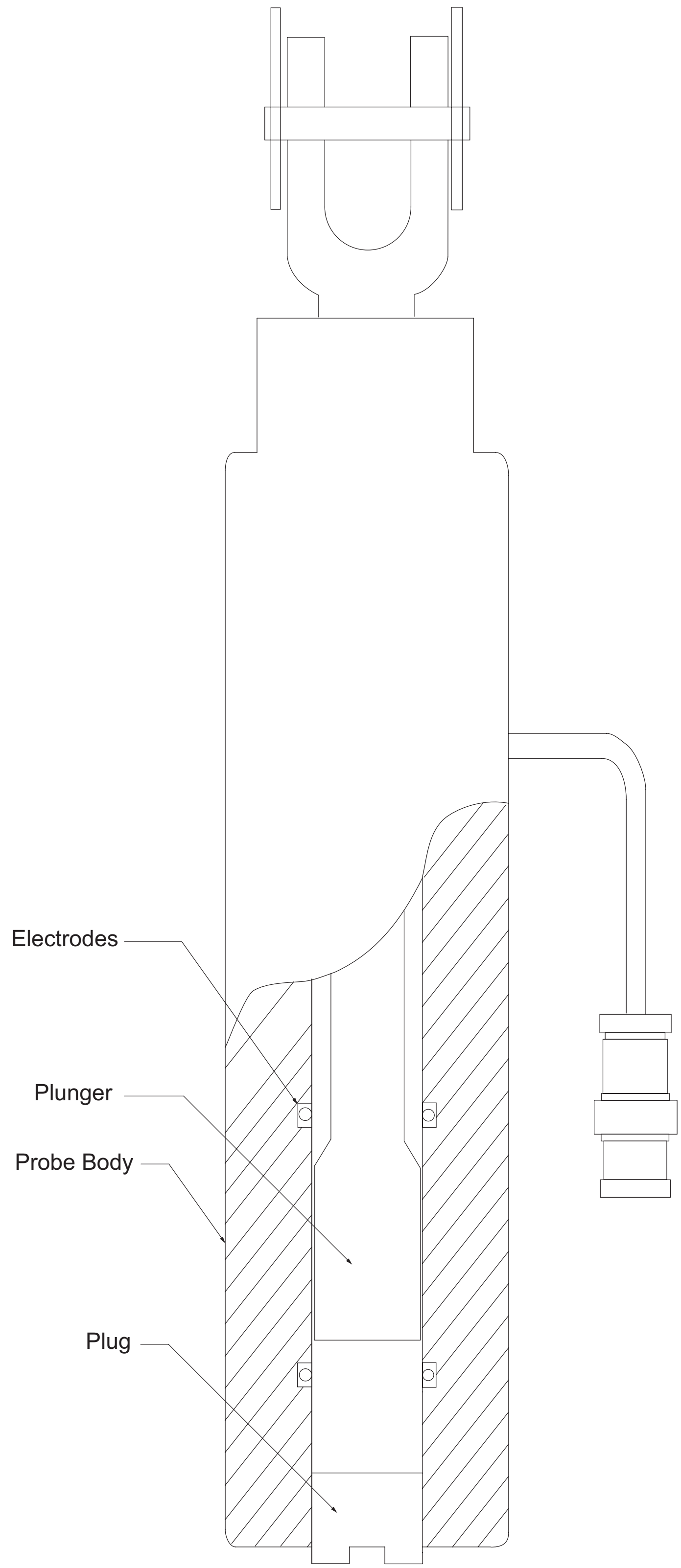

Figure 15. SCD Probe.

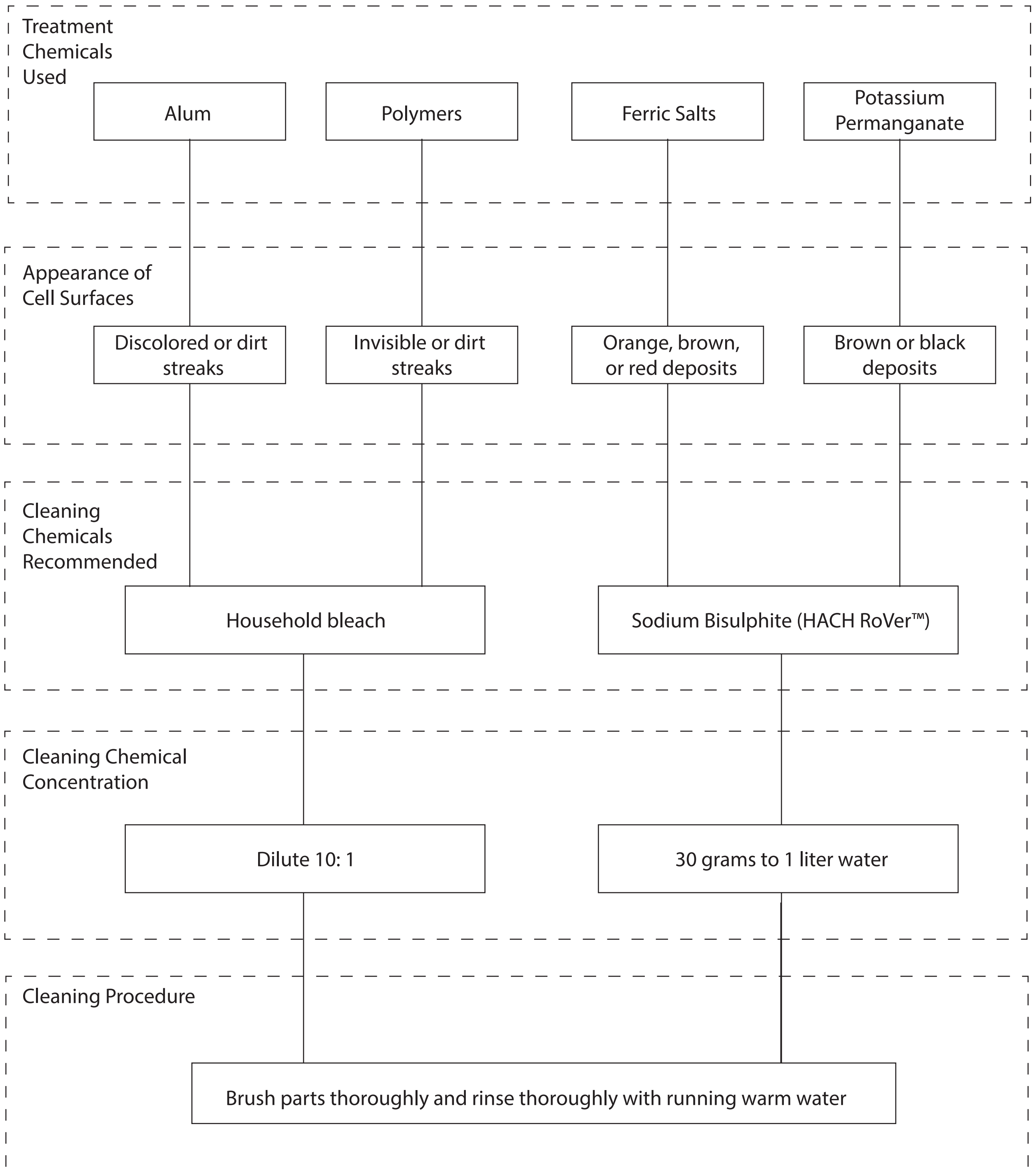

Figure 16. Cell Cleaning Procedures

⚠ WARNING DO NOT USE DETERGENT UNLESS CELL IS CONTAMINATED BY OIL OR GREASE.

SECTION 8 - TROUBLESHOOTING

When troubleshooting the SC4200, refer to Section 9 for disassembly instructions.

⚠ CAUTION **ALWAYS DISCONNECT POWER BEFORE DISASSEMBLING THE SCD UNIT.**

8.1 SYMPTOMS & REMEDIES

No meter display; no motor rotation . . .
- Check for power at terminal block (TB) connections.
- Check for proper wiring at TB connections.
- Remove front panel and check both fuses located at rear of circuit board.
- Check motor plug located at front right side of circuit board.
- Consult the Milton Roy factory.

No meter display; motor rotates . . . .
- Check for proper, wiring at terminal block connections.
- Remove front panel and check that the ribbon cable connecting the main circuit board to the display circuit board (on front panel) is securely plugged in at both ends.
- Consult the Milton Roy factory.

Meter display satisfactory, but motor fails to rotate or rotates erratically . . . . .
- Remove front panel and check motor plug on circuit board.
- Remove probe cover. Using care, manually rotate the sensor disc and bearing assembly to confirm free movement of the piston assembly. If the assembly binds or feels tight, then (a) check clearance between the disc and the sensor or (b) disassemble the probe and check for binding between the plunger and the probe body.
- Check and replace the motor.
- Consult the Milton Roy factory.

Display does not react to process changes or display reads zero
- Clean probe (see Section 7).
- Verify that sample requirements have been met (see Section 3).
- Increase instrument gain (see Section 4).
- Check for proper probe connection at underside of enclosure. Check the probe cable for kinks or fraying.
- Check that a jumper is installed between terminals 8 and 9 of the main board (TB3). If terminals 8 and 9 are connected to a recorder or other device, verify wiring and polarity.

Problem	Action
Display does not react to process changes or display reads zero (cont).	• Check that the pipe plug on the bottom of the probe housing is in place and tight. If a manual backwash valve (manual jet wash) has been installed, make sure that the valve is closed tightly. • Remove the front panel. Check that the probe signal cable (2-pin, thin black wire) and sensor signal cable (gray wire) are properly connected at their plugs in the circuit board. Check all cables for kinks or frays.
Display reading out of scale	• Check that a jumper is installed between terminals 8 and 9 of TB3. If terminals 8 and 9 are connected to a recorder or other monitoring device, verify wiring and polarity . • Check electrical connections on the main board and display board. • Adjust zero and gain settings to operate within range (see Section 4) . • Consult the Milton Roy factory:
Erratic display readings	• Clean probe (see Section 7). • Verify that sample requirements have been met (see Section 3). • Increase filter adjustment to remove small fluctuations in SCD signal and external electrical noise. • Check synchronous sensor disc under probe cover. Make sure disc is not contacting sensor and that disc and sensor slot are clear of dirt and debris. • Remove front panel. Check all electrical connections to main board, including sensor and probe cables. • Check that sample flow rate is steady and that all flow passages are clear. • Perform a jar test as outlined below. • Consult the Milton Roy factory.

8.2 JAR TESTING

If the SCD output continues to be erratic after the above remedies have been attempted, a jar test should be performed.

To perform a jar test, first disconnect the sample supply lines from the inlet and outlet of the probe and remove both barbed fittings. If the unit is equipped with an automatic jet wash, remove the jet wash valve and plug the hole at the bottom of the probe with a 1/2 inch NPT plastic pipe plug. If a manual jet wash is being used, remove any piping from the bottom of the probe and plug the hole as specified.

Obtain a representative process sample in a 1 liter (approximate size) container and immerse the probe in the sample so that it is above the inlet and outlet holes in the probe. After allowing a few minutes for the system to react and stabilize, observe the output.

1. If the output continues to be erratic, repeat the steps as outlined above to troubleshoot the unit. Confirm that the unit is stable and the output reads 12 milliamperes (or zero on the display if so equipped) with the probe disconnected. If still unsuccessful, consult the factory.
2. If the output stabilizes, check that the flow through sample is representative and well mixed (see Section 3). Also check for correct sample flow (approximately 2 to 4 liters per minute), and try reducing the flow to reduce cell turbulence.

A jar test can also be used to troubleshoot the SCD if it still does not respond to process changes after the previously noted remedies have been attempted. Obtain jar samples at 3 or 4 chemical addition rates. Immerse the probe in each sample and observe the output. If the output does not respond to the changes in chemical dose rates from sample to sample or has a very small response, increase the gain as outlined in Section 4. If an increased gain still provides no significant response, consult the factory.

SECTION 9 - CORRECTIVE MAINTENANCE

9.1 SPARE PARTS

To avoid delays in repairs, the following spare parts should be stocked for each SC4200:

3. Probe Assembly:

Standard Probe, Part #281-0260-000

High Flow Probe, Part #281-0260-010

(refer to SCD Model Code for correct probe)

4. Fuses, 1 Amp Slo-Blo:

Part #406-0333-020

Parts orders must include the following information:

1. Quantity required
2. Part Number
3. Part Description
4. SCD serial number (found on nameplate)
5. SCD model number (found on nameplate)

Always include the serial and model numbers in all correspondence regarding the unit.

9.2 RETURNING UNITS TO THE FACTORY

SCD units will not be accepted for repair without a Return Material Authorization (RMA), available from the factory or other Factory Authorized Service Centers.

All inquiries on part orders should be addressed to your local Milton Roy SCD sales representative or sent to:

Parts Department
Milton Roy Company
Flow Control Division
201 Ivyland Road
Ivyland, PA 18974-0577
Phone: (215) 441-0800
FAX: (215) 441-8620

9.3 DISASSEMBLY

The Milton Roy Streaming Current Detector has a modular design that allows easy removal of individual components and sub-assemblies.

Refer to Figure 17 and the parts lists to identify component location.

These instructions cover the removal and replacement of the following components and sub-assemblies:

1. Probe Assembly
2. Bearing Assembly
3. Front Panel and Display Circuit Board
4. Main Circuit Board
5. Drive Motor
6. Signal Cable
7. Timing Sensor Cable

For disassembly procedures on the optional automatic Jet Wash system, refer to Milton Roy Automatic Jet Wash manual 339-0034-000,

For other repairs, consult the Milton Roy factory.

⚠ WARNING **BEFORE PERFORMING ANY OF THESE PROCEDURES, DISCONNECT ALL POWER TO THE SCD UNIT AND SAFETY TAG THE SWITCH.**

9.3.1 Probe Assembly

1. Shut off sample flow and remove the sample feed and drain tubing at the barbed connections.
2. Disconnect the probe cable at the connector located at the bottom of the enclosure.
3. Remove the probe cover.
4. Remove the clevis pin and cotter pin holding the plunger to the bearing assembly.
5. Using the spanner wrench provided with the SCD, remove the bearing nut holding the probe housing to the enclosure. Remove the probe assembly.
6. Remove the plunger by pulling it straight out of the probe bore. Unscrew the plug on the bottom of the probe body.
7. Inspect the plunger surface and probe bore for abrasion and scratches which may necessitate replacement of the probe.
8. Clean the probe according to the instructions given in Section 7, Routine Maintenance.
9. Reassemble in reverse order. (Note: Install with the probe cable and vent hole to the rear of the unit.)

9.3.2 Bearing Assembly

1. Remove the side probe cover.
2. Remove the cotter pin and clevis pin holding the plunger to the crank. Swing the bearing assembly clear of the plunger.
3. Remove the two (2) screws holding the timing sensor to its bracket. Carefully lift the sensor clear of the timing disc.
4. Remove the screw holding the bearing assembly to the motor shaft and carefully pry the assembly off the shaft. Be careful not to damage or bend the timing disc during this procedure.
5. To reinstall the bearing assembly:
   a. Slide the bearing assembly hub onto the motor shaft. Align the locating pin in the end of shaft with one of the holes in the bearing assembly hub. Make sure that the hub is fully seated on the shaft and the pin fits into one alignment hole.
   b. Replace the screw holding the hub to the shaft. Use Loctite™ on this screw if available.
   c. Position the timing sensor on its bracket so that the timing disc passes cleanly through the sensor slot. Align the sensor so the disc is centered in the slot and then replace the screws that hold the sensor in place.
   d. Position the bearing assembly in the plunger and replace the pin and cotter.
   e. Replace the probe cover.

9.3.3 Front Panel and Display Board

1. Remove the four (4) button head screws holding the front panel to the enclosure.
2. Slide the panel forward. Carefully reach into the enclosure and unplug the ribbon cable from the main circuit board.
3. Lift the display panel assembly away from the enclosure.
4. To remove the circuit board assembly from the display panel, follow the steps below:
   a. Unplug the ribbon cable from the back of the display circuit board assembly and set aside.
   b. Unsnap the push button knobs from the two (2) alarm switches. If bezel nuts are used on the CAL /RUN and alarm switches, unscrew these.
   c. Remove the set screws holding the GAIN and ZERO knobs in place using the appropriate Allen wrench. Unscrew the square nut under each knob.
   d. Loosen, but do not remove, the four (4) nuts on the back of the circuit board assembly that hold the rear circuit board to the standoffs.
   e. Using a pair of pliers, carefully loosen each standoff at a point between the two circuit boards. Unscrew these standoffs until they are free of the studs mounted into the display panel.
   f. Carefully lift the circuit boards. up and away from the display panel. (Once the circuit board assembly is removed from the panel, it can be held together by using two (2) #8-32 screws through the front circuit board and into the standoffs separating the two boards.)
   g. To reassembly, follow the preceding directions in reverse. (Note: Replacement display circuit board assemblies are shipped with four (4) #8-32 panhead screws used to keep the circuit board assembly together. Remove and discard these screws before attempting to install the circuit board assembly on the front panel.)
   h. When replacing the GAIN and ZERO control knobs, align the knobs as follows:

GAIN: Turn the potentiometer shaft fully counter-clockwise. Set the knob so that the indicator line points to 1.

ZERO: Adjust the potentiometer shaft to approximately 50% of its rotation. Set the knob so that the indicator line points to 0.

9.3.4 Main Circuit Board

1. Remove the side panel. Disconnect all wires from the main board terminal blocks, noting their positions.
2. Remove the front panel following the directions under “Front Panel” and set aside.
3. Locate the signal cable and sensor cable. Unplug both from the main circuit board.
4. Locate the 2-pin motor plug on the right side of the main circuit board and remove.
5. Remove the two (2) screws holding the main circuit board in place; these are located at the front of the board. Do not remove the screws located at the rear of the board.
6. Slide the board forward. Lift the rear of the board up and over the rear mounting studs. Lift the front of the board up and carefully pull the board out through the front of the enclosure.
7. To install the main circuit board:
   a. Insert the board under the motor through the front of the enclosure. Make sure the terminal block is on the left side.
   b. Lift the rear of the board over the two back mounting studs.
   c. Slide the front of the board forward and under the two front panel mounting tabs.
   d. Align the slots in the rear of the board with the slots in the mounting studs and slide the board back in place.
   e. Replace the two (2) front mounting screws.
8. Continue the reassembly by following steps 1-4 in reverse.

9.3.5 Drive Motor

1. Follow the appropriate directions to remove the main circuit board and bearing assembly.
2. Remove the four (4) screws holding the motor to the enclosure. Carefully lift the motor out of the enclosure.
3. The motor gearbox is grease lubricated and not normally serviceable.
4. When reinstalling the motor, Loctite™ is recommended on the 4 mounting screws.

9.3.6 Signal Cable

1. Disconnect the probe cable at the connector located at the bottom of the enclosure.
2. Remove the front panel and main circuit board following the directions given in the appropriate sections.
3. Working inside the enclosure, loosen and remove the nut holding the signal cable bulk head connector to the enclosure.
4. Pull the connector and cable out of the enclosure from the outside.
5. Reassemble in reverse order

9.3.7 Timing Sensor Cable

1. Remove the probe cover.
2. Remove the sensor from its bracket mounted above the timing disk.
3. Remove the front panel following the directions given in the appropriate section.
4. Unplug the sensor cable from the main circuit board.
5. Working from the outside of the enclosure, carefully pry the sensor cable grommet out of its hole in the enclosure; then pull the cable out of the enclosure.
6. Reassembly in reverse order. When mounting the sensor over the timing disk, make sure the disk is centered in the sensor slot.

All parts without numbers are standard hardware items.
*Recommended spare parts are marked with an *.

Drawing Location Reference	Description	Part Number
A	Enclosure End Cover	281-0255-016
B	End Cover Gasket	225-0095-000
C	Button Head Mach Screw #10-32, 1/2″ long	405-0282-027
D	Display Panel Assembly (115 V)	284-0090-000
	Display Panel Assembly (230 V)	284-0090-010
E	Enclosure Assembly	284-0076-016
F	Motor Assembly (115 V)	228-0101-000
	Motor Assembly (230 V)	228-0101-010
G	Probe Cover	281-0258-016
H	Pan Head Screw #4-40	None
I	Sensor Cable Assembly	204-0173-000
J	Bearing Assembly	237-0099-000
K	Clevis Pin (Probe)	211-0055-062
L	Cotter Pin	404-0140-030
M	Probe Assembly (Standard) including:	281-0260-000
	Probe Housing	281-0259-000
	Plunger	214-0030-002
	Drain Plug	243-0062-000
	Probe Assembly High flow) including:	281-0260-010
	Probe Housing	281-0259-010
	Plunger	214-0033-000
	Drain Plug	243-0062-000
N	Probe Locknut	405-0320-090
P	Hex Nut #10-32	None
R*	Fuse /1 amp “slo-blo”)	406-0333-020
S	Main Circuit Board (115 V)	335-1524-010
	Main Circuit Board (230 V)	335-1524-020
T	Board Spacer	491-1400-010
U	Button Head Mach Screw #10-32, 3/4″ long	None
V	Conduit Hole Seal	408-0117-141
W	Ground Lug	None
X	Flat Washer 1/4″	None
Y	Hex Nut 1/4″ -20	None
Z	Wiring Label (SC4200)	253-0141-099
-	1/2″ Barb Connector (Standard Probe)	402-0505-141
-	1″ Barb Connector (High Flow Probe)	402-0505-221
-	Door Latch (not shown)	410-0171-000
-	1/2″ PVC Ball Valve	407-0252-011
-	Hook Spanner Wrench	413-0006-000

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